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National Aeronautics and
Space Administration

Research Announcement

Research Opportunities
in
Space Life Sciences

Advanced Human Support
Technology Program

1999

A Research Announcement for the
Life Sciences Division

Letters of Intent Due:	**February 16, 1999**
Proposals Due:	**April 15, 1999**

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NASA Research Announcement

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This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals to participate in research opportunities in the Advanced Human Support Technology (AHST) Program of the Space Life Sciences Division. This Announcement solicits proposals for research and for development of technologies that will enable humans to more efficiently and effectively live and work in space.

Habitability in the space environment is of prime concern to NASA, and the AHST Program directly addresses improvements in the spacecraft's habitability and safety.

The AHST Program seeks to fund the development of advanced technologies for use on the International Space Station (beyond the currently baselined technologies), on a Mars Transportation Habitat (TransHab) vehicle, or for use in a Lunar or Martian Habitat. Special emphasis is placed on those technologies that will have a dramatic impact on the reduction of the required mass, power, volume, and crew-time, and on increased reliability. This Announcement solicits research proposals in the Technology Readiness Level (TRL) range of 1 to 3 (Figure 1, Appendix A). Proposals addressing research and technology development at higher levels should contact the respective program representative as listed elsewhere in this document.

In particular, this Announcement solicits research and technological proposals, based upon sound principles, that are highly innovative even though they may contain some risk of failure. Bold, novel approaches to solving technology needs are particularly encouraged.

This Announcement will be updated and issued annually and will be the primary means of obtaining AHST research and technology proposals. A separate Life Sciences Division Announcement for the Gravitational Biology and Ecology Program, and the Biomedical Research and Countermeasures Program is scheduled to be released in mid-1999.

Research in the Life Sciences Division AHST Program, in consonance with NASA's mission, supports the following goals of the Human Exploration and Development of Space (HEDS) Strategic Enterprise:

- Explore the role of gravity in physical, chemical, and biological processes;
- Provide safe and affordable human access to space;
- Prepare to conduct human missions of exploration; and
- Increase the affordability of space operations through privatization and commercialization, and share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth.

The specific research and technology development elements of the AHST Program in this Announcement are Space Human Factors Engineering, Advanced Environmental Monitoring and Control, and Advanced Life Support. This Announcement is restricted to these AHST science and technology program elements only (see also Appendix A). Potential proposers should carefully read the program and element descriptions and focus their proposals on the specific research emphases defined in this Announcement.

Further details concerning the AHST Program and the preparation of proposals in response to this Announcement are included in the attached appendices.

- Appendix A provides technical information about AHST Program elements and other information that is applicable only to this Announcement.
- Appendix B contains a description of available NASA facilities.
- Appendix C contains detailed instructions that apply specifically to this NRA and includes the relevant application forms.
- Appendix D contains general instructions applicable to the preparation of proposals in response to NASA Research Announcements.

Proposals submitted in response to this Announcement may be for ground-based research or, with sufficient supporting ground-based research and testing having been completed, for limited types of space-flight experiments designed for the Shuttle middeck or for the earliest phase of utilization of the International Space Station. Because of the severe limitations of access to flight opportunities, proposals for flight experiments are very competitive and will only be considered based on solid ground-based research findings. Proposals may be for activities lasting up to three years and beginning in Fiscal Year 2000.

Proposals will be evaluated by an independent peer-review panel for overall scientific or technical value. Innovativeness, such as leveraging off recent advances in biological technologies, and potential for non-NASA applications will also be considered. Relevance to NASA's programmatic needs and goals and the feasibility of implementation will be evaluated separately by NASA. See Appendix A, Section V for more details on proposal evaluation.

A selection announcement will be made in September or October of 1999, pending budget availability. Funding of selected proposals will begin between October and December of 1999. The government's obligation to make awards is contingent upon the availability of annually appropriated funds from which payment for award purposes can be made and the receipt of proposals that the government determines are acceptable for award under this NRA. Annual continuation of multiple year awards is dependent on evidence of satisfactory progress.

It is anticipated that there will be approximately 12 awards for proposals submitted in response to this NRA and that each award will average approximately $150,000 for total annual costs, although requests for support may vary up to $350,000 per year.

> ***Proposers should note that the selection process includes an evaluation of the cost-effectiveness of each potential project and that proposals requesting substantially higher-than-average amounts of support may be at a disadvantage if the budget requested is not adequately justified.***

Participation in this Announcement is open to all individuals and all categories of organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other

government agencies. Proposals that will enhance or complement the scientific return from research currently being supported by industry or by other government agencies are encouraged. **Though, under certain circumstances, NASA will review proposals from non-U.S. institutions, NASA does not fund non-U.S. institutions** (see Appendix A, Section VI, Part C of this Announcement for details).

All awards made as a result of this NRA are to be funded as grants and will not be negotiated as contracts. Therefore, while proposals submitted by commercial organizations are allowed, they cannot include a "fee." Commercial organizations are encouraged to propose resource sharing in their cost plans.

A letter of intent (LOI) to propose is requested by February 16, 1999 by 4:30 PM Eastern Time (see Appendix A, Section VI, Part F of this Announcement). LOIs should be submitted via the World-Wide-Web (WWW) at:

http://peer1.idi.usra.edu/expro/loi/99_HEDS_01_loi.cfn

If you do not have access to the WWW, you may submit an LOI via email to:

loi@hq.nasa.gov

The subject heading of the e-mail message should read "LOI NRA 99-HEDS-01." If you do not have access to e-mail, you may submit an LOI by U.S. Postal Service or commercial delivery to the address below.

Proposals may not be submitted electronically. ***Proposals must be received by April 15, 1999 by 4:30 PM Eastern Time***. Proposals and LOIs mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

NASA c/o Information Dynamics, Inc.
SUBJECT: NASA Life Sciences Research Proposal
300 D Street, SW
Suite 801
Washington, DC 20024

Proposals and LOIs that are hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between 8:00 AM and 4:30 PM EST. The telephone number, 202-479-2609, may be used when required for reference by delivery services. Information Dynamics, Inc. (IDI) cannot receive deliveries on Saturdays, Sundays, or federal holidays. Upon receiving a proposal, IDI will send a postcard to the proposer confirming its arrival.

In order to be accepted as a complete submission, proposals **must include** completed copies of the appropriate forms provided in Appendix C. Special instructions apply to proposals by institutions, which are not entities of the United States (see Appendix A, Section VI, Part C of this Announcement).

The following items apply only to this Announcement:

Solicitation Announcement Identifier:	NRA 99-HEDS-01
Number of Proposal Copies Required:	Original + 25 copies
Letters of Intent Due:	February 16, 1999

Proposals Due:	April 15, 1999
Selecting Official:	Director Life Sciences Division Office of Life and Microgravity Sciences and Applications
Additional Programmatic Information:	Program Element Coordinator (indicated in table below) UL/Life Sciences Division NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0220 Fax: (202) 358-4168

Program Element	**Program Element Coordinator**
Space Human Factors Engineering	June Ellison
Advanced Env. Monitoring & Control	Elizabeth Cantwell, Ph.D.
Advanced Life Support	Charles Barnes, Ph.D.
Flight Experiments	Peter R. Ahlf

Your interest and cooperation in participating in this effort are appreciated.

Arnauld E. Nicogossian, M.D.
Associate Administrator for
Life and Microgravity Sciences and Applications

APPENDIX A
NRA 99-HEDS-01

Advanced Human Support Technology Program

I. Introduction

The Life Sciences Division of the National Aeronautics and Space Administration (NASA) seeks proposals for the Advanced Human Support Technology (AHST) Program in support of the Human Exploration and Development of Space (HEDS) Enterprise. This Announcement solicits scientific and technical proposals to be funded during Fiscal Year 2000, either for new research or for the continuation of research beyond the term specified in a previously funded proposal.

In particular, this Announcement solicits research and technological proposals, based upon sound principles, that are highly innovative, revolutionary, and achievable. High-risk/high-payoff proposals are encouraged, but justification for investment of research funds should be provided. Bold, novel approaches to solving technology needs are particularly encouraged. This Announcement solicits research proposals in the Technology Readiness Level (TRL) range of 1 to 3 (Figure 1). Proposals addressing research and technology development at higher levels should contact the respective program representative as listed elsewhere in this document.

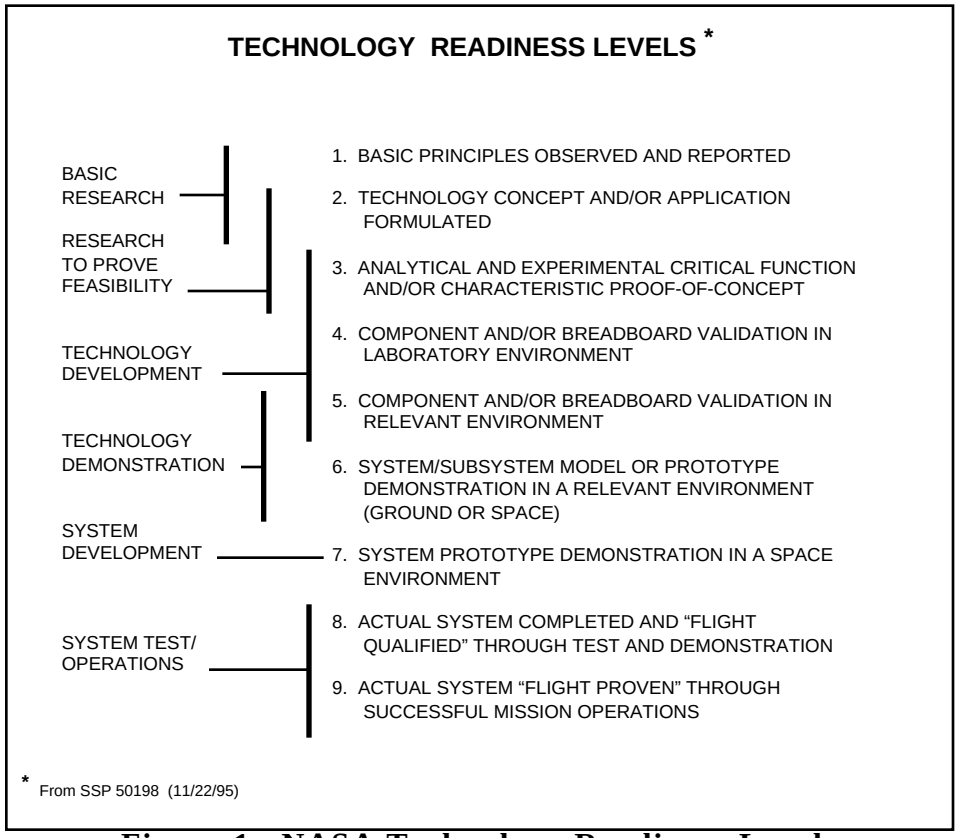

Figure 1. NASA Technology Readiness Levels

A separate Life Sciences Division Announcement for the Gravitational Biology and Ecology Program, and the Biomedical Research and Countermeasures Program is scheduled to be released in mid-1999. Other Announcements calling for focused research or utilization of unique resources may also be issued throughout the year.

Unsolicited proposals that are programmatically relevant but are received at other times in most cases will be held until the next annual review period or will be returned to the proposer without review. Proposals for research and technology development in areas outside those defined in this Announcement will be returned to the proposer without review. However, in all cases, NASA reserves the right to act in the best interests of the Federal Government in the matter of acceptance for evaluation of unsolicited proposals received outside the NRA annual cycle.

One goal of the Human Exploration and Development of Space (HEDS) Enterprise is to "share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth." Individuals participating in NASA's Life Sciences Division programs have a responsibility to foster the development of a scientifically informed public. Therefore, all participants in this NRA are strongly encouraged to promote general scientific literacy and public understanding of life sciences, the space environment, the Space Life Sciences programs, and their work through formal and informal education opportunities. Where appropriate, supported investigators may be required to produce, in collaboration with NASA, a plan for communicating their work to the public.

All proposers responding to this NASA Research Announcement need to quantify the benefit of their work to NASA in terms of minimization of mass, power and crew time utilized, increased system reliability, safety, or other factors for present or future missions.

At an appropriate point in the development of these technologies and after suitable evaluation, the appropriate NASA field center will become increasingly involved in any technology development in order to ensure that requirements for future use are being addressed. Appropriate points of contact at NASA are listed for each of the AHST Program Elements described in Section III of this Appendix.

Applicants are required to include in their proposal a projection showing the time frame for the anticipated use of their technology in or in support of operational systems. This requirement is not meant to favor near-ready technologies over concept-level, high-risk technologies, but rather to stimulate creative, innovative ideas for incorporating new technologies into flight systems as early as possible. In fulfilling this requirement, proposers are encouraged to refer to current Program Plans (see Bibliography, Section VII of this Appendix) and to contact appropriate NASA field center personnel.

NASA has a strong commitment to the ethical treatment of human and animal research subjects. Assurance of compliance with federal regulations regarding human subjects and/or animal care and use is required as part of the proposal submission process (see the "Special Matters" section in Appendix C of this Announcement). Applicants should note that review of proposals involving human or animal research subjects will not be undertaken if the required information is not supplied.

II. Proposal Types

Proposals may be submitted for ground-based or flight investigations.

1. Ground-Based Research and Technical Development
   It is expected that the majority of proposals submitted in response to this solicitation will fall into the category of technology development proposals, i.e., proposals to carry out a technical study in an Earth-based laboratory and having a clearly defined set of technical objectives relevant to NASA's mission. Proposals to conduct ground-based research leading to the development of technologies for testing and evaluation during the later phases of the International Space Station utilization (from 2002 onward) are particularly encouraged. If proposals require special Earth-based NASA facilities for their completion, proposers should contact pertinent NASA field centers to arrange for access to the facilities prior to submitting their proposal (see Appendix B of this Announcement).

2. Space-Flight Experiments
   Flight experiments will be accommodated on the carrier that is best suited to the execution of each experiment. Proposals are sought to carry out one of two special types of scientific and technical studies in space:

   - **ISS flight experiments** that can be implemented with the limited resources available on the International Space Station (ISS) during the early assembly phase (2002-2004)
   - **Short-duration flight experiments** that can be implemented primarily on the Shuttle middeck without the use of major mission resources

   Space studies proposed for the Space Shuttle or ISS are severely constrained by limitations on resources such as weight, power, and crew time and by the availability of flight hardware. Proposals requiring resources beyond the capabilities defined in this Announcement should **not** be submitted at this time. Flight investigations must represent mature studies strongly anchored in previous ground-based research and/or previous flight research (see Section IV of this Appendix) and must be thoroughly justified.

   A proposal may be multidisciplinary or interdisciplinary, involving combinations of these research and technology development elements. For such proposals, the teaming arrangements should be clearly stated. Proposals should include a well-defined development plan that can be accomplished within **three** (or fewer) years.

III. Advanced Human Support Technology (AHST) Program

The mission of the Human Exploration and Development of Space (HEDS) Strategic Enterprise is to open the space frontier by exploring, using, and enabling the development of space. In using the space environment, the Enterprise will develop the tools and skills to live and work in space, to take advantage of its unique environment for conducting research in science and engineering, and to generate new technology.

The Advanced Human Support Technology Program contains three Program Elements:

- Space Human Factors Engineering
- Advanced Environmental Monitoring and Control
- Advanced Life Support

Note: It is important that the prospective investigator read the relevant program element sections carefully, as many of the areas of

programmatic emphases are different from those appearing in previous Life Sciences Division NASA Research Announcements.

A. Space Human Factors Engineering

Element Description

The Space Human Factors Engineering (SHFE) element of the Advanced Human Support Technology (AHST) Program is designed to integrate knowledge about human capabilities and system engineering methodologies into spacecraft design, mission planning, and related ground operations. The SHFE element also encourages the development of new processes and procedures; draws on human factors expertise in aeronautics to optimize crew training, automated systems design, proficiency, and productivity; and uses relevant analog studies in simulators as well as in extreme and isolated environments.

Another component of Space Human Factors is Behavior and Performance research, which focuses on psychological, psychosocial, and psychiatric studies and their impact on performance. The Behavior and Performance element will be addressed in a separate NASA Research Announcement to be released in mid-1999 by the Biomedical Research and Countermeasures Program. The emphasis in this NRA (99-HEDS-01) is on Space Human Factors **Engineering**.

The SHFE element includes four distinct mission functional areas:

- Human Capabilities and Limitations
- Performance Assessment and Maintenance
- Skill Analysis
- Information Requirements and Tools for Design

Proposals Sought for FY 2000

Highest priority in FY 2000 will be given to those **technologies or techniques** from which NASA can derive the earliest possible benefit. To be considered for funding in FY 1999, proposals should focus on one or more of the following mission domain areas (it should be noted that these research topics are <u>not</u> given in priority order):

- **Safety.** For example, studies regarding appropriate cautions, warnings, and risk management; designs required to support safe maintenance, both routine and unusual; and analysis of safe handling of hazardous materials.

- **Habitability & Work Environment.** For example, studies and development of personnel requirements for privacy, hygiene, etc.

- **Tools and Equipment.** For example, studies regarding uniform, well-designed tool sets for manual and/or gloved (e.g., EVA) use; and sufficiency of tools to support planned and contingency tasks.

- **Workload & Task Characteristics.** For example, evaluation of tasks and tools for optimal human performance; determination and scheduling of appropriate fatigue countermeasures; and ensuring that expected crew performance is within known SHFE bounds.

- **Mission Support**. For example, studies of appropriate decomposition of tasks focusing on automated components; and "on-line" documentation of procedures.

- **Maintenance & Logistics.** For example, studies regarding training required for normal and unusual events.

Proposals in other areas of emphasis may receive lower priority.

Flight Experiments

Space-flight missions represent a unique opportunity for researchers to analyze habitability and other human factors issues uniquely associated with long-duration missions. Human factors issues need to be researched and resolved in order to better plan future missions to ensure optimal crew productivity and safety. Some basic goals of SHFE flight proposals are:

- Characterize the ISS environment from a habitability standpoint
- Evaluate crew procedures for resupply inventory management, loose equipment tracking/location, etc.
- Perform mental and physical workload measurements on the crew to assess crew interaction with hardware interfaces and to assess adequacy of crew functional responsibilities

Extravehicular Activity (EVA) Technologies

The SHFE element also includes activities within the element emphasis as they relate to advanced EVA. Infusion of technologies relating to helmet design are sought. These include advanced wireless communication, voice recognition, advanced displays and controls, on-orbit replaceable unit (ORU) visors, CO_2 washout improvements, low powered LED lights, and improved visibility and mobility. Mechanical counterpressure technology is needed for improvement to support glove dexterity, mobility, and metacarpal improvement durability. Eventually, this technology may lead to an advanced "skin suit"-type full body garment which could eliminate the bulky pressurized suits now associated with EVA.

Technologies to improve EVA garments are also sought. Astronauts involved in extended EVA require internal and external garments that provide optimal protection from the harsh environment of space while affording them maximal range of motion and dexterity for work outside the spacecraft. Technologies are solicited to improve astronaut survivability following a puncture of a Thermal Micrometeoroid Garment (TMG) and its underlying bladder material. Additional technologies will be needed in the forms of advanced material insulation, permeability, mobility, and interchangeability. Technologies should also focus on reducing weight and increasing on-orbit maintainability, reliability, and performance. Innovative and creative modular designs for suit sizing need to reach a maturity level to support exploration programs. Further details are available in the EVA Roadmap (see NASA Supporting Documents, below).

NASA Technical Contact

In order for applicants to better understand NASA's scientific and technological needs, and to enable more effective transfer of their scientific and technological advances to NASA, it would be advantageous for applicants to explore opportunities to interact with NASA Space Human Factors personnel. The appropriate contact persons are:

Ms. June Ellison
Code UL Life Sciences
NASA Headquarters
300 E Street, SW
Washington DC 20546-0001
phone: 202-358-0576
email: jellison@hq.nasa.gov

Mr. Robert Bond
Mail Code SP
NASA Johnson Space Center
2101 NASA Road One
Houston, TX 77058
phone: 281-483-3705
e-mail: rbond@ems.jsc.nasa.gov

Supporting Documents

Further information on this element of the AHST Program can be obtained from the following documents (see Bibliography, Section VII of this Appendix for details):

- Space Human Factors Program Plan (1995)
- Space Human Factors: Critical Research & Technology Definition (1996)
- EVA Roadmap (1998)

These supporting documents can be accessed via the Internet at the following WWW address:

http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm

At this address, choose **NRA** or **Research Opportunities**. Under **Program Plans and Requirements Documents**, choose the appropriate Space Human Factors document or **Extravehicular Activity**.

B. Advanced Environmental Monitoring and Control

Element Description

The Advanced Environmental Monitoring and Control (AEMC) Element of the AHST Program develops advanced technologies that monitor the physical, chemical, and microbial environments of both the human compartments and life support systems of current and future space craft and extravehicular activity (EVA) systems. The AEMC Element also develops advanced control systems to maintain these environments in the states necessary for crew health and safety. The goal is to evolve measurement and control capabilities to meet all future requirements through autonomous evaluation, diagnosis and response.

Proposals Sought for FY 2000

Proposals are sought for sensor technologies and control concepts and implementation that will dramatically advance the goal of optimization of mass, power, crew time, reliability, and system response speed. The environments of interest include air, water, surfaces, food supplies, and all life support processing technologies.

Proposals may include the development of new technologies as well as the refinement and microminiaturization of currently available sensors. Technologies that may meet these needs with multi-use capability are desireable. Sensors that can monitor multiple media (e.g., air and water) have the potential to reduce mass and volume in terms of redundant units, i.e., one unit may serve as a backup for two systems. Environmental monitoring technologies may be useful for noninvasive physiological measurements or for EVA, as well as for habitat use.

For FY 2000, the emphasis of the AEMC Element will be primarily on:

- **Sensors for *in situ* monitoring of water quality**

- **Microbial monitoring in the environments of interest using methods based on state-of-the-art developments in integrated biological/solid state devices**

- **Technologies for sample acquisition and preparation that support state-of-the-art sensors, minimize the need for crew time, and meet the overall need for low power consumption and no waste generation**

Proposals in other areas of emphasis may receive lower priority.

Because discreet elements of advanced monitoring technologies may be proposed (e.g., sample preparation, sensor, data acquisition or data fusion), NASA may desire to select only a portion of the proposed effort and/or that the applicant participates with other investigators in a joint investigation. In this case, the applicant will be given the opportunity to accept or decline such partial acceptance or teaming with other investigators prior to a NASA selection. Where participation with other investigators as a team is agreed to, one of the team members will normally be designated as its leader or contact point.

Flight Experiments

Microgravity effects can play a strong role for AEMC technologies in the space environment. Sensors that monitor or use liquids such as water generally face microgravity effects. Analysis of head space (the air space above a liquid sample) constituents, a common technique in ground-based laboratories, is problematic in microgravity.

Flight experiments should have as their objective the test or validation of monitoring and control technologies in the space environment. Of interest is the monitoring and control of environmental parameters including air/water major constituents and trace contaminants, as well as the microbial environment in air, in water, and on surfaces. Initial activities should focus on the evaluation of advanced environmental sensors and controls that will help to ensure crew health and safety while moving well beyond ISS baseline in terms of minimal mass and power consumption.

Space station configurations will be available for testing advanced environmental monitoring technologies onboard.

Extravehicular Activity (EVA) Technologies

Further technology development is needed for atmospheric monitoring and control.

NASA Technical Contact

In order for applicants to better understand NASA's scientific and technological needs, and to enable more effective transfer of their scientific and technological advances to NASA, it would be advantageous for applicants to explore opportunities to interact with NASA Advanced Environmental Monitoring and Control personnel. The appropriate Advanced Environmental Monitoring and Control contact persons are:

Dr. Elizabeth Cantwell
Code UL Life Sciences
NASA Headquarters
300 E Street, SW
Washington, DC 20546-0001
phone: 202-358-2334
email: ecantwel@hq.nasa.gov

Dr. Darrell L. Jan
Jet Propulsion Laboratory
MS 125-224
4800 Oak Grove Drive
Pasadena, California 91109-8099
phone: 818-354-4542
email: djan@jpl.nasa.gov

Supporting Documents

- Advanced Environmental Monitoring and Control Technology Requirements Document (1998)
- Advanced Environmental Monitoring and Control Strategic Plan (1996)
- EVA Roadmap (1998)

These supporting documents can be accessed via the Internet at the following WWW address:

http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm

At this address, choose **NRA** or **Research Opportunities**. Under **Program Plans and Requirements Documents**, choose the appropriate Advanced Environmental Monitoring and Control document, or **Extravehicular Activity (EVA)**.

Related areas:

Research proposals to establish environmental standards for human health will be solicited through the Environmental Health Element of the Biomedical Research and Countermeasures Program described in the Gravitational Biology and Ecology and Biomedical Research and Countermeasures Programs NRA to be released in mid-1999.

Control of specific subsystem processes is included in System Modeling and Control within the ALS Element of the AHST Program described in Section III, Part B of this Appendix.

C. Advanced Life Support

Element Description

The Advanced Life Support (ALS) Element of the AHST Program was initiated to develop advanced regenerative life support systems to support human missions in space. Such missions, including the International Space Station (ISS) and possible future planetary exploration, may last from months to years. Resupply of life support materials is expensive and, in some cases, may be impossible, necessitating greater self-sufficiency of the subsystems used on the mission.

Subsystems must be developed that fully recycle air and water, and recover resources from solid wastes. This may involve the utilization of plants for air, water, and solid waste recycling, as well as for food and for the psychological well being of the crew. Systems integration, thermal control, and food processing technologies are also important considerations in an Advanced Life Support System.

Proposals Sought for FY 2000

Proposals are sought that will dramatically advance the goals of optimization of mass, power, volume, crew time, and reliability for an Advanced Life Support System. In particular, the mass requirement of the life support system serves as a good aggregate indicator of life support system performance, which is critical in determining the cost of human space flight. Proposers should include a discussion of how their proposed work will impact system mass.

For FY 2000, the primary emphases of the ALS Element of the AHST Program will be in the following areas:

- **Solid waste processing/resource recovery from solid wastes.** Solid waste processing, or more correctly, resource recovery from solid wastes, includes methods to extract useful materials from solid wastes generated by a human space exploration mission. Therefore, the constraints of mass, volume, power, thermal control, and crew time requirements apply as they do to all aspects of a human mission. Approaches to processing solid wastes to recover useful materials must be lightweight, small, low power, low heating or cooling, and run autonomously. Solid wastes include human metabolic wastes, inedible plant biomass, paper products, uneaten food, and other waste solids likely to be in a space-based vehicle and/or habitat. Research proposals covering all facets of solid waste processing directed at resource recovery are solicited.

- **Food processing methods (for ALS-produced crops, post-harvest to table) that are applicable to a transportation/habitation vehicle and/or planetary surface stay.** Food processing in this context involves only those functions necessary to process food crops grown in an Advanced Life Support System into storable food, food ingredients, or meals for crews in space or on a planetary surface.

Proposals in other areas of emphasis may receive lower priority.

Flight Experiments

Knowledge of the effects of microgravity on life support systems is essential for the success of the HEDS Program. A major technology goal of ALS development is to resolve issues of performance in microgravity through research and evaluation in space. Therefore, the program element solicits proposals to examine the gravitational sensitivity of candidate life support processes, components, and subsystems.

Extravehicular Activity (EVA)

In addition to the above technologies directed at intravehicular activities, the ALS element also includes activities that address life support problems associated with advanced EVA beyond the ISS. Specifically, further technology development is needed in the areas of advanced thermal control systems, long duration batteries, and integration of these subsystems. Research is needed in certain areas of portable life support system (PLSS) technology to develop highly reliable, low-power pumps for fluid management, and small (MEMS/nano) technologies to support regenerable subsystems that can be packaged into easily maintained micro-climate control systems. PLSS technologies should consist of plug and play technology to support maintenance operations during exploration.

NASA Technical Contact

Due to the applied nature of the ALS Program Element, proposals solicited by this Announcement tend primarily to be for technology development and applied, rather than fundamental, research. Research undertaken and technologies developed for ALS tend to find ready application and rapid integration into NASA's ongoing programs.

In order for applicants to better understand NASA's scientific and technological needs and to enable more effective transfer of their scientific and technological advances to NASA, it would be advantageous for applicants to explore opportunities to interact with NASA Advanced Life Support personnel. The appropriate Advanced Life Support contact persons are:

Dr. Charles Barnes
Code UL Life Sciences
NASA Headquarters
300 E Street, SW
Washington, DC 20546-0001
phone: 202-358-2365
email: cbarnes@hq.nasa.gov

Dr. Donald Henninger
Mail Code EC3
NASA Johnson Space Center
2101 NASA Road One
Houston, TX 77058
phone: 281-483-5034
email: dhennin1@ems.jsc.nasa.gov

Proposers should refer to the Advanced Life Support web site for more information:

http://pet.jsc.nasa.gov

Supporting Documents

Further information about the Advanced Life Support program element can be found in the following documents (see Bibliography, Section VII of this Appendix for details).

- Advanced Life Support Program Plan (1998)
- Advanced Life Support Requirements Document (1998)
- Advanced Life Support Current Technology Assessment Matrix (1998)
- Advanced Technology for Human Support in Space: NRC Report (1997)
- EVA Roadmap (1998)
- ALS Roadmap (1998)

These supporting documents can be accessed via the Internet at the following WWW address:

http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm

At this address, choose **NRA** or **Research Opportunities**. Under **Program Plans and Requirements Documents**, choose the appropriate Advanced Life Support document or **Extravehicular Activity.**

IV. Flight Experiments

Proposals for space flight experiments for the time period between 2002 and 2004 may be submitted. All flight experiments must address one or more of the research programs and emphases described in this Research Announcement.

It is expected that the majority of experiments selected will be performed on the International Space Station (ISS). A small number of opportunities may exist for short duration experiments that do not require ISS resources and can be accommodated in the middeck area of the Space Shuttle. Because this prospect is uncertain, proposals for research appropriate for ISS will have the highest priority for selection and funding.

The experiment opportunities are highly constrained in a number of ways. *Proposals requiring resources beyond the capabilities defined below should not be submitted in response to this Announcement.*

Potential applicants should recognize that, given the limited flight opportunities that are available, the flight experiments area is likely to be one of the most competitive arenas within space life sciences for 1999. Only flight experiment proposals representing mature studies strongly anchored in previous or current ground-based or flight research or technical evaluation will be selected. Ground-based research may, and often must, represent one component of a flight experiment proposal. That research should be limited to activities that are essential for the final development of an experiment for flight, such as definition of flight protocols and ground control activities of the flight experiment. In this case, only one (flight) proposal need be submitted.

Applicants proposing flight experiments are **required** to provide the information requested on Form C (Appendix C). Flight experiment proposals should emphasize the actual experiment, duration requirements, and experiment conditions. Descriptions of the functional capabilities available to support experiments are included in Appendix B of this Announcement.

Some investigators may wish to develop their own unique experiment hardware to work in conjunction with the facilities and functional capabilities described in this Document. Please note that the development of experiment-unique equipment will require additional funding. In the event that such items are proposed, they should be clearly identified as new developments. Proposals for major hardware items or facilities to be developed by the investigator will not be considered.

Flight experiments should be proposed as if the actual flight of the experiment will occur between 2002 and 2004. Experiments that cannot be initiated within this time period should not be submitted. Proposals requesting only one flight to meet their proposed research goals have a higher probability of being accomplished, but multiple flight opportunities may be granted if justified. Informed consent of human subjects must be obtained prior to carrying out any human-related study in space, and potential proposers should be aware that obtaining such informed consent will involve a uniform process regardless of the country of origin of the proposer or astronaut.

Once selected, flight investigators and NASA must agree on the duration of the period (nominally one year) following receipt of specimens and data during which their investigation will be completed. At the end of this period, investigators must provide a final report to NASA and should publish the results of their experiments in appropriate peer-reviewed journals. All suitable experimental and reduced data must be submitted to NASA in a form appropriate for archiving in the Space Life Sciences Data Archive, where it will be available to the scientific community.

Finally, potential applicants should be aware that selection for flight is a multi-step process.

1. Following the initial evaluation of flight proposals, a small group of investigators will receive a letter informing them that their experiment has been selected for definition.
2. During the definition phase, NASA will interact with the applicant and determine whether the proposed experiment can actually be carried out on a space mission, and to refine the cost estimates for the space-flight experiment.

3. At the end of the definition phase, NASA will select a smaller group of investigations to be developed for flight. **Normally, full investigator research funding does not begin until the initiation of the development phase.**

   Note: All experiments selected for flight are subject to possible deselection in accordance with NASA Life Sciences Division deselection policy available on the WWW at: http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm

   All experiments are also subject to re-review every three years to determine continued retention.

A. ISS Flight Experiments

Research opportunities will be available during the construction phase of the International Space Station. The research will be accomplished during utilization flights when the Shuttle visits the ISS and during the time period between the utilization flights when the permanent onboard crew will act as experiment operators and, if necessary, as subjects. The duration of microgravity exposure during the 2002 to 2004 time period can, in theory, be indefinite with periodic disturbances every 30 days caused by U.S. and Russian transportation vehicle docking activities.

During the period of time covered by these solicitations, AHST research is restricted to utilize a limited hardware set. A list of the hardware and the functional capabilities of this hardware are described in Appendix B of this Announcement.

It is expected that crew availability for science operations, power, and logistics resupply (frequency and mass to and from ISS) will be severely constrained throughout 2001 to 2003. The primary opportunities to transport scientific equipment, supplies, and samples will be on the utilization flights of the Shuttle. However, modest capabilities for research-related deliveries and sample returns will be available on assembly flights that will occur every 40 to 90 days. Refrigerated stowage for transport of samples on the Shuttle will be very limited, and during certain time frames, refrigerated stowage may not be available on the Space Station. Power outages may also be experienced during the assembly of ISS. Experiments with few or simple in-flight activities have the greatest potential for selection during this time frame due to their simpler logistic requirements.

B. Short Duration Flight Experiments

Short duration experiment proposals submitted in response to the research solicitations are restricted to experiments that can be accommodated on the Shuttle for approximately 11 days of microgravity exposure. The experiments are usually stand-alone studies that require limited crew training and involvement to execute. In limited opportunities, it is possible to take advantage of the location in the Shuttle middeck to obtain late pre-flight installation and early post-flight retrieval of materials. Experiments that do not require Orbiter power are more easily accommodated.

C. Potential Research Mission

It is possible that a Space Shuttle research mission may become available over the next couple of years. In the event that this becomes a reality, proposals submitted to these solicitations may be selected for such a mission.

V. Proposal Evaluation and Awards Selection Process

The following information is specific to this NRA and **supersedes** the information contained in Sections I and J of Appendix D, *Instructions for Responding to NASA Research Announcements.*

All proposals must comply with the general requirements of the Announcement. Upon receipt, proposals will be reviewed for compliance with the requirements of this Announcement. This includes:

1. Submission of complete proposals on or before the due date specified in this Announcement (see Section VI, Part F of this Appendix).
2. Responsiveness to technology areas described in this Announcement.
3. Submission of a complete proposal, including a project description that is not more than 20 pages in length (see Instructions, Appendix C).
4. For revised versions of proposals previously submitted to NASA, submission of a proposal with clearly marked revisions and a preface containing an explanation of how the revised proposal has addressed criticisms from previous NASA review (see Instructions, Appendix C).
5. Where relevant, submission of appropriate Institutional Review Board (IRB) or Animal Care and Use Committee (ACUC) certification for all proposals using human or animal test subjects. Certification must be specific to the proposal. NASA shall require current IRB or ACUC certification prior to award (see Special Matters, Appendix C of this Announcement). If IRB or ACUC review is unavoidably delayed beyond the submission of the application, enter "Pending" on line 9b or 10b of Form A. The certification must be received within 60 days after the due date for which the application is submitted. If certification is not received within 60 days after the application due date, the application will be considered incomplete. For additional information relative to IRB or ACUC approval and definitions of "human subjects" and "vertebrate animals," see Application for a Public Health Service Grant (PHS 398) at the web site:
   http://www.nih.gov/grants/funding/phs398/phs398.html
6. Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding three years in duration (see Section VI, Part A of this Appendix).
7. Submission of all other appropriate forms as required by this NASA Research Announcement (refer to Checklist for Proposers, Form H, Appendix C).

Note: At NASA's discretion, non-compliant proposals may be withdrawn from the review process and returned to the proposer without further review.

The overall review process for each proposal submitted in response to this Announcement will include the following factors:

- Intrinsic scientific or technical merit including degree of innovation
- Feasibility of Implementation (where relevant)
- Flight Feasibility (where relevant)
- Relevance to NASA programs; proposed project cost

The most important factor in the evaluation is intrinsic scientific or technical merit, followed by feasibility of implementation, flight feasibility, relevance to NASA programs and priorities, and cost.

A. Merit Review

The **first tier of review** will be a merit evaluation by a panel of scientific and/or technical experts. The number and diversity of experts required will be determined by the response to this NRA and by the variety of disciplines represented in the proposals relevant to the research emphases described in Section III of this Appendix. The merit review panel will assign ***a score from 0-100*** or a score of "not recommended for further consideration" based upon the intrinsic scientific or technical merit of the proposal. This score will reflect the consensus of the panel.

The score assigned by this panel ***will not be affected by the cost of the proposed work nor will it reflect the programmatic relevance (meaning the relative priority of the proposed work to NASA)***. However, the panel will be asked to include in their critique of each proposal any comments they may have concerning the proposal's budget and relevance to NASA.

The goal of NASA-sponsored research and development in Advanced Human Support Technology is to further our understanding and development of the technologies that will support human life during future crewed missions, enabling humans to more effectively and efficiently live and work in space. Reviewers will be asked to consider the following five criteria for each proposal in order to judge the likelihood that the proposed research will have a substantial impact on the pursuit of this goal. Each of the criteria will be addressed and considered in assigning the overall score.

1. **Innovation:** Does the project employ novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
2. **Significance:** Does this study address an important problem within the context of the AHST Program as described in this NRA? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field?
3. **Approach:** Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics? Is the proposal high risk and high payoff?
4. **Investigator:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
5. **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

Proposals are evaluated for scientific/technical merit using the five criteria listed above and are given a numerical score on a scale from 0 (lowest merit) to 100 (highest merit). Descriptions of the scoring categories used in assessing merit and the range of scores associated with each are presented below.

DESCRIPTIVE FEATURES	SCORING RANGE
EXCELLENT: A comprehensive and thorough proposal with one or more major strengths. No major or minor weaknesses exist.	90 - 100
VERY GOOD: A proposal having no major weaknesses and demonstrating overall competence. One or more major strengths have been found, and strengths substantially outbalance any minor weaknesses that exist.	80 - 89
GOOD: A proposal having no major weaknesses and in which the strengths and weaknesses on the whole are in balance but strengths somewhat outweigh weaknesses.	65 - 79
FAIR: A proposal having some major weaknesses and in which weaknesses outbalance any strengths.	50 - 64
POOR: A proposal having several major weaknesses or weaknesses that demonstrate a lack of overall competence that would require a major proposal revision to correct.	0 - 49

B. Feasibility of Implementation Review

The **second tier of review** (where relevant) will be an evaluation of the feasibility of implementation of the results of the proposed work (i.e., the resulting technology or research results) into an operational NASA system. This review will be conducted by an engineering and technical review team assembled by NASA and will evaluate the feasibility of implementing the resulting technology or research results utilizing available NASA flight and/or ground facilities. The purpose of the review is to assess the likelihood that the proposed research, if completed successfully, would lend itself to continued research and technology development in the context of the Advanced Human Support Technology Program goals.

C. Flight Feasibility Review

The **third tier of review** (applicable only to flight experiment proposals) will be an evaluation of the feasibility of implementation of the proposed work on a space platform. This review will be conducted by a team qualified to determine the feasibility of implementing the proposed projects using available flight and ground facilities.

The following criteria will be used in performing the flight feasibility review:

- **Functional Requirement:** Will the available flight hardware meet the functional requirements of the experiment?

- **Space Platform Resource Requirements:** To what extent will this experiment consume the launch vehicle capacity and flight platform resources (such as crew time and electrical power) that are projected to be available? Are sufficient resources available? Does this experiment require such a large amount of the available resources that it will preclude conduct of other experiments? Based on the required number of samples or subjects, can the experiment be carried out within a reasonable period of time?
- **Operational Impacts:** For experiments that utilize the crew as research subjects, could the implementation of these experiments, even if considered safe, lead to an impact to the performance of the crew subjects?

D. Evaluation of Programmatic Relevance and Cost

The **fourth tier of review for all proposals** consists of the evaluation of two factors: programmatic relevance and cost. This review will be conducted by NASA program scientists and managers, who will evaluate the programmatic relevance and cost of each proposal as follows:

- **Programmatic Relevance:** In this context, programmatic relevance is the establishment of the relative priority of proposed projects for the AHST Program, based on current needs and considerations of programmatic balance.
- **Cost:** Evaluation of the proposed cost includes consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds.

E. Development of Evaluation Findings

The information resulting from these four levels of review will in turn be used to prepare **evaluation findings** developed by NASA program scientists and managers for each of the AHST program elements described in this Announcement. This recommendation will be based on:

1. The score for merit from the peer review panel
2. The results of the feasibility of implementation review (where relevant)
3. The results of the flight feasibility review (where relevant)
4. The programmatic relevance and cost of each proposal

These **evaluation findings** will be presented by NASA program scientists and managers to the Director of the Life Sciences Division. Selection for funding will be made by the Director of the Life Sciences Division.

VI. Program Management Information

A. Type of Awards to be Made

Funding increment:	One year at a time
Funding duration:	One to 3 years, depending on proposal requirement, review panel recommendation, and continuing contribution of the activity

Number awarded:	Approximately 12 expected, depending on number received, review panel recommendation, and available funding
Average funding:	$150,000 per year
Funding range:	Up to $350,000 per year

Role of NASA Field Centers

The NASA AHST field center with primary programmatic responsibility will have a primary role in oversight of these awards and will be responsible, with NASA's Life Sciences Division, for annually evaluating their progress and out-year plans.

B. Eligibility

All categories of institutions are eligible to submit proposals in response to this NRA. Principal Investigators may collaborate with universities, Federal Government laboratories, the private sector, and state and local government laboratories. In all such arrangements, the applying entity is expected to be responsible for administering the project according to the management approach presented in the proposal.

The applying entity must have in place a documented base of ongoing high quality research in science and technology, or in those areas of science and engineering clearly relevant to the specific programmatic objectives and research emphases indicated in this Announcement. Present or prior support by NASA of research or training in any institution or for any investigator is not a prerequisite to submission of a proposal or a competing factor in the selection process.

All categories of institutions are eligible to submit proposals in response to this NRA, but only approved proposals from U.S. institutions will be selected for funding.

C. Foreign Proposals

Although NASA does not fund proposals from non-U.S. entities, NASA will accept for review proposals from non-U.S. entities that require use of NASA facilities. Such proposals should not include a cost plan. Proposals from non-U.S. entities and U.S. proposals that include non-U.S. participation must be endorsed in writing by the respective government agency or funding/sponsoring institution in the country from which the non-U.S. participant is proposing. This endorsement must indicate that:

- The proposal merits careful consideration by NASA
- If the proposal is selected, sufficient funds will be made available by that country or agency to undertake the activity as proposed

U.S. co-investigators who are collaborating on non-U.S. proposals must ensure that their scientific role is clearly delineated in the proposal, that their expertise is shown to make a substantial contribution, and that their funding requirements (funding requirements for U.S. Co-I's only) are included in the proposal.

All proposals must be typewritten in English. All non-U.S. proposals will undergo the same evaluation process as those originating in the U.S. Non-U.S. proposals and U.S. proposals that include non-U.S. participation must follow all other guidelines and requirements described in this

NRA. All proposals must be received by the established closing date. Those received after the closing date will be treated in accordance with NASA's provisions for late proposals. Successful and unsuccessful proposers will be contacted directly by the NASA Program Office coordinating this Announcement. Copies of these letters will be sent to the sponsoring government agency.

Should a proposal from a non-U.S. entity or a U.S. proposal with non-U.S. participation be selected, NASA will arrange with the non-U.S. sponsoring agency for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency will each bear the cost of discharging its respective responsibilities.

D. Program Reporting

It is expected that results from funded research will be submitted to peer-reviewed journals as the work progresses. Only published papers that acknowledge NASA's support and identify the grant or contract will be counted as resulting from the research project and used to evaluate its productivity.

Annual Reporting

Investigators will be expected to provide NASA with annual summary information. This information will consist primarily of:

- an abstract
- a bibliographic list of publications
- copies of publications
- a statement of progress, including a comparison with the originally proposed work schedule

This information will be made available to the scientific community and will be used to assess the strength of the Division's programs. It will also serve as the basis for determining the degree of progress of the project.

Annual Task Book Reporting

The NASA Life Sciences Division publishes a comprehensive annual document titled, Life Sciences Program Tasks and Bibliography (or Life Sciences Task Book), which includes descriptions of all peer-reviewed activities funded by the division during the previous fiscal year. The Task Book is an invaluable source of information for NASA Life Sciences as well as the scientific and technical communities.

Investigators are required to provide information for this publication on an annual basis. Please note that this requirement is in addition to the annual report which investigators are required to submit at the end of each funding cycle. Supplying the requested information for the Life Sciences Task Book does NOT fulfill the requirement for the annual report. Unlike the annual report, information requested for the Task Book must be for the government's fiscal year rather than the project funding cycle and brief.

The information requested for inclusion in the Task Book consists primarily of:

- an abstract
- a brief statement of progress during the fiscal year

- a brief statement of benefits of the research with respect to life on Earth
- a bibliographic list for the fiscal year
- a copy or reprint of each publication listed in the bibliography for the fiscal year

Note that although this publication will be made available to the general scientific community, it is not a substitute for traditional scientific reporting in journals and elsewhere.

Final Report

A final report is required which shall include all peer-reviewed publications.

Implementation Plan

Investigators will be required to submit an implementation plan one year prior to the project end date. This plan will describe the process by which the results of the project will be implemented into a NASA program. Since construction of this plan will likely require one or more visits to NASA field centers, **appropriate travel funds should be accounted for in the proposal** (see Section VI, Part E in this Appendix).

Flight Experiment Reports

Investigators selected to carry out space flight experiments are expected to provide NASA with two reports:

1. A "quick-look" report of preliminary flight results that is due one month after the space flight takes place.
2. A final report containing all data and information on the flight study is due approximately one year after all required data/materials are provided by NASA to the investigator. At this time, all of the data must also be provided to NASA for placement in the Life Sciences Data Archive; data in this archive will be made available to the scientific and technical community.

E. Other Considerations

Travel If travel is planned, the proposal must include travel funds for the following:

- Annual Principal Investigator meeting
- Visits to NASA field centers (as many as necessary)
- Presentation at professional society meeting

Resident Research Associates Intramural investigators who plan to request Resident Research Associate (RRA) postdoctoral fellows supported by the NASA-NRC Program should include this information in their list of personnel and budget.

F. Letter of Intent and Proposal Submission Information

Letters of Intent To facilitate proposal processing, potential Principal Investigators are requested to confirm plans to submit a proposal responding to this Announcement by sending a ***letter of intent (LOI) to propose by February 16, 1999 by 4:30 PM EST.*** The letter of intent, which should be no more than two pages, should contain:

- The names, addresses, and telephone numbers of a single principal investigator and all co-investigators
- Identification of the research emphasis described in this Announcement that is most closely aligned with your proposal
- A descriptive title of the research or technical proposal
- A brief yet thorough summary describing the proposed research
- The major participating institutions
- Up to six (6) key words that best describe the research area of the pending proposal

LOIs should be submitted via the WWW at:

http://peer1.idi.usra.edu/expro/loi/99_HEDS_01_loi.cfn

If you do not have access to the WWW, you may submit an LOI via email to:

loi@hq.nasa.gov

The subject heading of the e-mail message should read "LOI NRA 99-HEDS-01." If you do not have access to e-mail, you may submit an LOI by U.S. Postal Service or commercial delivery in the same manner as proposals.

Proposals An original signed proposal, plus twenty-five (25) complete copies of that proposal and a 3.5-inch computer disk (containing an electronic copy of the Principal Investigator's name, address, telephone and fax numbers, e-mail address and the complete project title and abstract, as provided on Form B) in either Macintosh or PC format ***must be received by April 15, 1999 by 4:30 PM Eastern Time*.**

Proposals and Letters of Intent mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

NASA c/o Information Dynamics, Inc.
SUBJECT: NASA Life Sciences Research Proposal
300 D Street, SW
Suite 801
Washington, DC 20024

Proposals and Letters of Intent hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between the hours of 8:00 AM and 4:30 PM Eastern Time. The telephone number, (202) 479-2609, may be used when required for reference by delivery services.

Note that Information Dynamics, Inc. (IDI) cannot receive deliveries on Saturdays, Sundays, or federal holidays.

G. Proposal Schedule

The following schedule is planned for the acquisition of investigations under this Announcement:

Letter of Intent to Propose Due	February 16, 1999

Proposal Due	April 15, 1999
Selection Announcement	September - October 1999
Initial Funding Available	October - December 1999

VII. Bibliography

For information on obtaining documents, refer to note at end of Bibliography

1. **National Aeronautics and Space Administration Strategic Plan. (1998)** NASA, Washington, DC **http://www.hq.nasa.gov/office/nsp/**

2. **NASA's Enterprise for the Human Exploration and Development of Space: The Strategic Plan. (1996)** NASA, Washington, DC **http://www.osf.hq.nasa.gov/heds/hedsplan.html**

3. **Advanced Technology for Human Support in Space. (1997)** Report of the National Research Council (NRC) Committee on Advanced Technology for Human Support in Space, Aeronautics and Space Engineering Board (ASEB), National Academy Press, Washington DC (ISBN 0-309-05744-2; 1997) **http://www.nap.edu**

4. **NASA Series of Discipline Science/Technology Plans and Requirements Documents** produced by the program elements of the Advanced Human Support Technologies Program in the Life Sciences Division, NASA, Washington, DC:

   a. **Advanced Life Support Program Plan (1998)**
   b. **Advanced Life Support Program Requirements (1998)**
   c. **Space Human Factors Program Plan (1995)**
   d. **Space Human Factors: Critical Research & Technology Definition (1996)**
   e. **Advanced Environmental Monitoring and Control Strategic Plan (1996)**
   f. **Advanced Environmental Monitoring and Control Program: Technology Development Requirements (1998)**

   Available at: http://peer1.idi.usra.edu/peer_review/prog/prog.html

5. National Aeronautics and Space Administration, Life Sciences Division, Washington, DC 20546, Cumulative bibliographies of publications resulting from research supported by the Division:

   a. **Space Human Factors Publications: 1980-1990. (1991)** K.J. Dickson (Ed.). NASA Contractor Report 4351. *(NTIS # N9120620 - $22.00)*.
   b. **Publications of the NASA Controlled Ecological Life Support System (CELSS) Program: 1989-1992. (1994)** J.V. Powers (Ed.). NASA Contractor Report 4603. (*NTIS #N9430122 - $17.50).*

6. **A Strategy for Space Biology and Medical Science for the 1980s and 1990s. (1987)** National Academy of Sciences, National Research Council, Committee on Space Biology and Medicine; Jay M. Goldberg, Committee Chairperson; National Academy Press, Washington, DC *(NTIS #N8924024 - $46.50).*

7. **Assessment of Programs in Space Biology and Medicine. (1991)** National Academy of Sciences, National Research Council. Committee on Space Biology and Medicine, National Academy Press, Washington, DC *(NTIS #N9313327 - $19.50).*

8. **Exploring the Living Universe: A Strategy for Space Life Sciences. (1988)** National Aeronautics and Space Administration Advisory Council. Life Sciences Strategic Planning Study Committee; Frederick C. Robbins, Committee Chairperson; National Aeronautics and Space Administration, Washington, DC.

9. **Space Biology and Medicine: Volume II, Life Support and Habitability. (1994)** F.M. Sulzman and A.M. Genin (Eds.), American Institute of Aeronautics and Astronautics, Washington, DC.

10. **Space Physiology and Medicine, 3rd ed. (1994)** A. Nicogossian, C. Huntoon, and S. Pool (Eds.) PA: Lea & Febiger, Philadelphia.

11. **Strategic Considerations for Support of Humans in Space and Moon/Mars Exploration Missions. (1992)** National Aeronautics and Space Administration Advisory Council, Aerospace Medicine Advisory Council, National Aeronautics and Space Administration, Washington, DC.

12. **Spaceline**. An on-line bibliographic database, is available for searching for references to publications about space life sciences research.
    Phone: (301) 295-2482 Email: SPACELINE@mx3.usuhs.mil
    http://spaceline.usuhs.mil **http://lgm.nlm.nih.gov** (MEDLINE)

13. **Space Life Sciences Data Archive (LSDA).** An on-line database containing descriptions and results of completed NASA-sponsored flight experiments.
    Phone: (281) 483-7876 Email: lsda@semail.jsc.nasa.gov
    http://lsda.jsc.nasa.gov

14. **Technical Assessment Matrix**
    http://salamander.idi.usra.edu/matrix/search.htm

15. **EVA Roadmap (1998) http://www.jsc.nasa.gov/xa/advanced/roadmap.html**

16. **ALS Roadmap (1998) http://pet.jsc.nasa.gov/roadmap/index.html**

Obtaining documents

Many of the documents cited here may be ordered through your library or through the National Technical Information Service (NTIS). Documents available through NTIS are accompanied by their NTIS order number and price. To order a document through NTIS, call 1-800-553-6847. You may also send e-mail to **orders@ntis.fedworld.gov** or access the NTIS web site at **http://www.ntis.gov**. If you are unable to locate a document through this means, please call (202) 358-4180 and leave a detailed message and your return phone number.

APPENDIX B
NRA 99-HEDS-01

Advanced Human Support Technology
Space Life Sciences
Ground Facilities and Flight Hardware

Introduction

This Appendix provides a list of ***potentially available*** ground facilities and flight hardware that may support research and technology development for the Advanced Human Support Technology Program. Proposers to this NASA Research Announcement who wish to use these facilities or hardware must contact NASA and coordinate such use ***before submission of their proposal.***

Proposals that depend upon the availability of NASA ground facilities or flight hardware for the successful completion of their work must include ***at the time of submission*** a signed letter from the facility manager indicating that the required facility or hardware is available for use to accomplish this work and is compatible with the goals of the proposal.

Table 1. Potentially Available Ground Facilities and Flight Hardware

Ground Facilities and Flight Hardware	***Ground***	***Flight***	***Flight***
		Short Duration	***Long Duration***
Advanced Life Support Systems Integrated Test Bed	X		
Chemical Sensor Test Facility (CSTF)	X		
Space Human Factors Facility at JSC	X		
Biological Research in Canisters (BRIC)		X	X
Petri Dish Fixation Unit (PDFU)		X	X
KSC Gaseous Nitrogen (GN_2) Freezer		X	X
KSC Plant Growth Facility (PGF)		X	
KSC Plant Growth Unit (PGU)		X	
Microgravity Plant Nutrient Experiment (MPNE)		X	
Data Loggers		X	X
Astroculture™ Plant Growth Unit		X	X
Plant Generic BioProcessing Apparatus (PGBA)		X	X
Biomass Production System (BPS) Plant Growth Unit		X	X

Ground Facility: Advanced Life Support Systems Integrated Test Bed

Description

The **Advanced Life Support Systems Integration Test Bed (ALS Systems Integration Test Bed) at the NASA Johnson Space Center** is a multichamber facility specifically configured for conducting long-duration testing of large-scale integrated life support systems with human test subjects in a closed, confined environment. The test bed will be constructed in two stages — a three-chamber configuration and a five-chamber configuration — which will support integrated testing of air revitalization, water recovery, food production, waste processing, and thermal control systems with human interaction. Additionally, the test bed will support a host of scientific studies associated with long-term crew confinement within the multichamber facility. The test bed in its three-chamber configuration is anticipated to become operational in 2001.

For further information, contact Leah Pate, (281) 483-4544, or Terry O. Tri, (281) 483-9234, at the Johnson Space Center.

Ground Facility: Chemical Sensor Test Facility

Description

The **Chemical Sensor Test Facility (CSTF)** at the NASA **Jet Propulsion Laboratory** houses apparatus specifically configured for testing gas phase chemical sensors. Up to five major gas constituents can be mixed, with the mixture ratios being changeable in real-time via computer control. The system can be used to provide controlled mixtures of the target gas for sensor evaluation, or to create specialized atmospheric mixtures at desired temperature and humidity as a background for sensing of trace gases. The CSTF has been used to provide realistic flow conditions for *in situ* sensors. Some aqueous phase sensor test apparatus is also available.

For further information, contact Dr. Darrell Jan at the Jet Propulsion Laboratory, telephone: (818) 354-4542.

Ground Facility: Space Human Factors Facilities

Description

These labs are managed by the Flight Crew Support Division, located at the Johnson Space Center and consist of the Graphics Research and Analysis Facility (GRAF) and the Anthropometry and Biomechanics Facility (ABF).

The **Graphics Research and Analysis Facility** has systems for computer modeling of humans and environments, providing anthropometric, kinematic and visibility analyses of humans working in 1-g, zero-g, or partial-g. GRAF has access to strength and size databases and a physically-based system for computer modeling illumination for camera/eye vision with the ability to empirically collect luminance and illuminance data. It also has a large collection of models of the Shuttle, Spacelab, Spacehab, and Space Station modules in which to perform this integrated analysis of humans working in space both EVA and IVA.

The **Anthropometry and Biomechanics Facility** collects and analyzes strength, force, and motion data in the lab, in the Weightless Environment Test Facility (WETF), and in the KC-135 zero-g aircraft. Equipment includes Lido dynamometers, Ariel Motion Analysis Systems, and waterproofed and KC-135-qualified force plates. The ABL personnel are experienced in collecting data from suited subjects, as well as on the Precision Air Bearing Floor.

For further information, please contact Dr. Francis Mount at the Johnson Space Center at (281) 483-3723.

Flight Hardware: Biological Research in Canisters (BRIC)

BIOLOGICAL RESEARCH IN CANISTERS - 100 (BRIC-100)

Dimensions: 114.3 X 381 mm
Power Requirement: None
Weight: 4.4 lb.

The BRIC-100 canister is an anodized-aluminum cylinder with threaded lids on each end. This canister provides containment and structural support for the specimen support hardware and specimens. The outside dimensions of the BRIC-100 canisters are 114.3 mm OD X 381 mm long. The size of the BRIC-100 canister allows it to accommodate standard laboratory 100 mm Petri plates.

The BRIC-100 canisters have lids which allow passive gas exchange of O_2 and CO_2 through a semipermeable membrane. The bottom and top lids of each canister have twenty-five 0.5 mm holes and a Teflon membrane (pore size 0.5 µm). Two septa are located in the lid to allow gas sampling. Underneath this lid, the semipermeable membrane is attached and supported by an anodized-aluminum ring. The ring and membrane assembly are supported by five stainless steel

screws. If gas exchange is not required, the semipermeable membrane and capture ring can be replaced by an aluminum capture plate to provide a closed experimental environment.

The hardware inside the canister consists of nine (9) polycarbonate 100 mm Petri plates held in place by a Petri dish cage insert. The insert is manufactured from 304 stainless steel and contains glide rivets made from acetal. The rack provides both vibration isolation and airspace between each Petri dish.

The BRIC-100 canisters are flown in sets of three; a standard middeck locker can accommodate up to six (6) BRIC-100 canisters. This hardware was flown aboard STS-64, STS-70, and STS-77.

BIOLOGICAL RESEARCH IN CANISTERS - 100VC (BRIC-100VC)

Dimensions: 36 OD X 16.5 mm
Power Requirement: None
Weight: 2.7 lb.

The BRIC-100VC canister is an anodized-aluminum cylinder. The lid of the canister uses a toggle switch and O-ring assembly which allows quick sealing and removal of the lid. Quick disconnect valves are also present on the top lid and bottom of the canisters to allow for gas purge. The bottom of the canister has sufficient storage space for passive temperature and relative humidity recorders, also referred to as data loggers (see section entitled “Data Loggers”).

The BRIC-100VC canister provides containment and structural support for the specimen support hardware and specimens. The outside dimensions of the BRIC-100VC canisters are 114.3 mm OD X 159 mm long. The size of the BRIC-100VC canister allows them to accommodate standard 100 mm laboratory Petri plates. The BRIC-100VC canisters are completely sealed to allow for a controlled experimental environment.

The top and bottom lids of the BRIC-100VC canister each have a quick disconnect valve. Using these valves, a specific atmosphere can be sealed inside the canister, providing control of the experimental conditions.

The BRIC-100VC canisters are flown in sets of nine (9), and a standard middeck locker can accommodate up to eighteen (18) canisters. The BRIC-100VC canisters were flown aboard STS-78 in June 1996 and were launched on STS-81 in January 1997 for a four month mission aboard the Russian space station Mir.

BIOLOGICAL RESEARCH IN CANISTERS - 60 (BRIC-60)

Dimensions: 26 OD X 32 mm
Power Requirement: None
Weight: 1.9 lb.

The BRIC-60 canister is an anodized-aluminum, 82 mm diameter cylinder with an upper and lower chamber. There are four pressure relief holes in each chamber to meet the rapid depressurization

requirements of the Space Shuttle and are designed to maintain a light-tight environment inside the canister chambers. This canister will fit inside the Life Sciences Laboratory Equipment (LSLE) gaseous nitrogen (GN_2) freezer.

Twelve 60 mm Petri dishes (total of 24 per canister) or thirteen (13) Teflon tubes (total of 26 per canister) for growing seedlings can be placed inside each canister chamber. Lithium hydroxide and Purafil have been flown inside these canisters for specimens which produce carbon dioxide (CO_2) and ethylene, respectively.

Up to five canisters can be flown at ambient middeck conditions in a standard middeck locker. If the LSLE GN_2 freezer is utilized for freezing, the flight configuration is two (2) canisters and one (1) GN_2 freezer per middeck locker. The BRIC-60 canisters have supported six Space Shuttle experiments: one Growth Hormone Concentration and Distribution (GHCD) experiment, and five Biological Research in Canister payloads (BRIC-01/BRIC-03/BRIC-06/BRIC-09/BRIC-10).

BRIC-LIGHT EMITTING DIODE (BRIC-LED)

Dimensions: 18 X 9 X 9.5 mm
Power Requirement: 10 W
Weight: 4 lb

The Biological Research In Canisters-Light Emitting Diode (BRIC-LED) is an anodized-aluminum container which provides one level of containment to its contents. A complement set of hardware, the Petri Dish Fixation Unit (PDFU), rests inside the BRIC-LED. The PDFU is a specialized holder for a standard 60 mm Petri dish which delivers fixative to the sample within the Petri dish. Each BRIC-LED can house six (6) PDFUs. Light Emitting Diodes (LEDs) placed inside the canister deliver a specified light intensity to each Petri dish location within the canister. The lid of each BRIC-LED is secured using ten (10) screws, and includes a silicon gasket to provide containment between the lid and the base. Six (6) holes are present in the lid of the BRIC-LED for insertion of a PDFU "actuator" attachment which allows fixation of the specimens. Each hole is sealed using a silicone septum. An interface box provides power to the canisters, using the Orbiter as its power source.

The lid of each BRIC-LED houses a circuit board which contains red surface mount LEDs (6 per BRIC) for specimen illumination; switches (6 per BRIC) for controlling on/off status of red LEDs; and green surface mount LEDs (6 per BRIC) for verification of the on/off status of the red LEDs. Each red LED is located on the bottom of the circuit board, with a corresponding green LED located on top of the lid. The green LEDs provide the crew with a method of verifying red LED illumination/operations. Each red LED provides a wavelength of 640-660 nm red light to the samples located inside the canister via a Pyrex light pipe (the light pipe is a component of the PDFU). The switches are located on the top of the circuit board to switch the LEDs on or off at the appropriate time. An additional orange LED is located on top of the circuit board to indicate that power is being properly supplied to the canister's circuitry.

The BRIC-LEDs remain unpowered at launch, after which time their power supply is connected to Orbiter power for the duration of the mission. Following connection to the Orbiter power supply,

the BRIC-LED is automatically powered up. At specific times, the surface mount LEDs, which provide light treatments to each PDFU, are depressed to initiate the experiment.

The BRIC-LED Stowage Tray is used to house the BRIC-LED canisters and power distribution box. The tray is a single stowage tray, and was designed to the dimensions of a standard single stowage tray. The tray is made of anodized aluminum and contains a power connector to allow Orbiter power to be connected to the locker before flight. The tray can also feature an enclosed fan to prevent samples from reaching extreme temperatures. The BRIC-LED canister and stowage tray were flown on STS-87 as part of the Collaborative Ukrainian Experiment (CUE).

For further information, please contact Guy Etheridge at the Kennedy Space Center at (407) 867-4550.

Flight Hardware: Petri Dish Fixation Unit (PDFU)

PETRI DISH FIXATION UNIT (PDFU)

Dimensions: 8.5 X 7.5 X 2.5 mm
Power Requirement: None
Weight: 0.30 lb

The Petri Dish Fixation Unit (PDFU) is a complement set of hardware which interfaces with the BRIC-LED. Six (6) PDFUs are contained within each BRIC-LED.

The major components of each PDFU include the following items:

1. a chamber for the 60 mm Petri dish
2. a chamber for fixative storage
3. a piston for forcing the fixative into the specimen chamber
4. a light rod to channel the illumination provided by the red LEDs

Each PDFU provides two levels of containment to the fixative, which is loaded into the fixative chamber.

Each PDFU consists of a body of polycarbonate which is milled to house the above mentioned chambers. The specimen chamber houses the bottom half of a standard off-the-shelf 60 mm Petri dish. The top half of the 60 mm dish is not needed to house the specimen since the top of the assembly (e.g., the PDFU cover and manifold) acts as a cover. A set of three O-rings provides a seal between the PDFU cover and the polycarbonate body. The fixative chamber and the specimen chamber are separated by a check valve to prevent unwanted/early fixation of the specimens.

Flight Hardware: Petri Dish Fixation Unit (PDFU) (continued)

An additional feature of the PDFU is a light rod which directs the light from each red LED on the BRIC-LED's canister's circuit board into the PDFU specimen chamber. This glass light rod is constructed of Pyrex and is sealed into the dish using epoxy.
The inside of the PDFU has sufficient storage for a passive temperature recorder (substituted for a specimen), or data logger. A PDFU that contains a data logger does not contain any fixative.

The PDFU was flown to support the Collaborative Ukrainian Experiment on STS-87.

ACTUATOR TOOL

The Actuator Tool is designed to provide easy fixation of specimens in the Petri Dish Fixation Unit (PDFU). The tool consists of a handle and an advancing body. A stainless steel rod is enclosed in polyethylene to prevent any exposure to sharp edges, and is loaded into the advancing body of the tool.

When fixation is required, the tool is unstowed and a rod is removed from a stowage bag. The rod is then inserted into the inner body of the tool. The actuator tool is then attached to the septum hole in the BRIC-LED lid. The tool is rotated by a quarter turn, which temporarily attaches to the lid of the BRIC-LED. The crew member squeezes the handles, thereby advancing the rod into the BRIC-LED lid and into the PDFU. In order to maintain the appropriate levels of containment in the BRIC-LED and PDFU, the actuator rod is not removed from the PDFU until after fixation. The silicone septum in the lid of the canister provides a seal around the rod when it rests in the BRIC-LED.

For further information, please contact Guy Etheridge at the Kennedy Space Center at (407) 867-4550.

Flight Hardware: KSC Gaseous Nitrogen (GN_2) Freezer

KENNEDY SPACE CENTER GASEOUS NITROGEN (GN_2) FREEZER

Dimensions: 116 OD X 52 X 39 mm
Power Requirement: None
Weight: 23.7 lb.

The Kennedy Space Center Gaseous Nitrogen (GN_2) Freezer uses similar technology as the LSLE freezer which has flown regularly on the Space Shuttle and the Mir Space Station. The major differences are that the GN_2 Freezer can hold samples at a temperature of -196C for 21 days; the freezer is stored in a double, rather than single, locker; and insulation material has been added to the vacuum chamber.

Flight Hardware: KSC Gaseous Nitrogen (GN_2) Freezer (continued)

The aluminum outer tank of the freezer houses an internal tank containing the CAB-O-SIL absorbent material used to hold the gaseous nitrogen. The CAB-O-SIL, manufactured by the Cabot Corporation, is a hydrophilic fumed silica whose surface has been rendered hydrophobic by treatment with a silicone fluid. The CAB-O-SIL is insulated with a combination foil, molecular sieve and palladin oxide getter. The insulation material is sealed between the outside tank and the inner tank. The gaseous nitrogen is held in the absorbent material by a vacuum and the insulation material. The freezer has a valve which ensures the integrity of the vacuum container. The sample area inside the internal tank can hold up to four canisters 6" in length and 3.7" in diameter.

The freezer charging process begins approximately 96 hours before launch by filling the freezer with liquid nitrogen. The charging process continues over a period of 48 hours until the absorbent material is completely saturated. The freezer is drained of liquid nitrogen approximately one hour before turnover of the payload for installation into the Orbiter. The freezer is installed in the vertical position in the Orbiter middeck.

For further information, please contact Guy Etheridge at the Kennedy Space Center at (407) 867-4550.

Flight Hardware: KSC Plant Growth Facility (PGF)

PLANT GROWTH FACILITY (PGF)

Dimensions: 411 X 226 X 483 mm
Power Requirement: 115 W
Weight: 65 lb.

The Plant Growth Facility (PGF) replaces a standard SSP middeck locker. The PGF's first flight was aboard STS-87 in support of the Collaborative Ukrainian Experiment (CUE).

The PGF is composed of the following subsystems: Control and Data Management System (CDMS), Fluorescent Light Module (FLM), Atmospheric Control Module (ACM), Plant Growth Chambers (PGC), Support Structure Assembly (SSA), and the Generic External Shell (GES).

The CDMS provides stand-alone control of the PGF during the entire experiment cycle from ground preparation, through launch, on-orbit operations, landing and post-flight recovery. The system consists of a computer, signal conditioning module, and power module.

The CDMS computer provides stand-alone control of the PGF, making it a fully automatic facility not requiring continuous supervision. The CDMS computer interfaces allow crew interaction on-orbit through the PGF front panel, and user interaction during experiment preparation and ground processing via the Ground Support Equipment (GSE) laptop computer.

Flight Hardware: KSC Plant Growth Facility (PGF) (continued)

The CDMS computer provides the following functions in support of PGF operation: Data acquisition and environmental control based on real-time multi-tasking software; Stand-alone control of the PGF via on-board experiment protocols; Crew Interface via display, keys and status LEDs on the PGF front panel, and menu-driven software; and Experiment protocol development via communication through an RS-232 serial port and software residing on the GSE laptop computer. A lithium battery provides backup power to the computer clock in the event the 28V supply is interrupted.

The CDMS Signal Conditioning Module (SCM) provides the electrical and data interface between the PGF sensor signals and the CDMS computer. The SCM consists of a single custom printed circuit board with connecting wiring to the CDMS computer and each of the sensor devices. The SCM provides sensor power and sensor signal conditioning (filtering and gain control).

The Plant Growth Chambers (PGC) for the PGF are a new design, though they are based on the current Plant Growth Units' (PGU) PGCs. This hardware is used for the CHROMEX series of payloads.

The PGC subsystem consists of a base, lid, mesh filter, gas sampling port, and a humidity/temperature sensor. The base is molded polysulphone, and the lid is transparent polycarbonate. The PGC air filters are located along the sides of the PGC lid and are held in place by a sealed frame. The air filters allow the ACM airflow through the PGC while maintaining the water-tight environment within the PGC. The PGC interfaces for the filter-lid, lid-base, and the sensor are liquid-tight seals to prevent the loss of nutrient solution or water.

The PGF Support Structure Assembly (SSA) consists of the SSA tray, slide rails, and front panel. The CDMS, FLM, ACM, and PGCs are located on the SSA tray. The slide rail system allows the SSA tray to be hard-mounted to the Generic External Shell (GES) and provides slide-out access to the PGF for ground handling. The front panel, which contains the PGF main power switch, LCD display, and four button keypad, is hinged to allow the SSA tray to slide out from the GES. A component cooling loop is provided to the subsystems mounted on the SSA.

Current design of the Generic External Shell (GES) is identical to current SSP lockers, except it is fabricated from aluminum instead of Kevlar®. The GES is designed to be a generic housing for many different middeck experiments and allows the mounting of the payload contents using the slide rail system.

The Power Module (PM) of the CDMS subsystem provides conditioned power to the electrical elements of the PGF derived from the Orbiter 28 VDC supply or from the PGF battery backup system. The PM provides the following functions: regulated and unregulated DC power from the Orbiter supply; +28 VDC unregulated with EMI Filtering; +28, +24, ±12, and +5 VDC with In-rush current limiting and EMI filtering; and control of a cabin air cooling fan via thermostats and air flow sensors.

The PGF Fluorescent Light Module (FLM) provides a source of light for plant growth. The FLM provides a light intensity of 220 ± 20% mmol/m^2/s^2 and the output spectrum is in the 400 - 700 nanometer wavelength to provide the plants with the maximum photosynthetically active radiation (PAR). The FLM is mounted next to the Plant Growth Chambers (PGC) to provide a uniform diffuse source of light on plants in the chambers.

The FLM is composed of the following components: outer housing and reflector chamber; two fluorescent bulbs; DC electronic ballasts; line filter and TTL compatible switch; Spectralon reflective liner; DC boxer fans; and thermal cutoff switch. The FLM will operate from the 28 VDC power bus with a TTL compatible power On/Off switch. The input power passes through a high performance DC power filter before being applied to the power switch, thermal cutoff switch, and then to the DC electronic ballasts which provide high frequency (40 kHz) power to the fluorescent bulbs. Each bulb is powered separately from its own electronic ballast. Four irradiance level sensors will monitor the output of the bulb array.

The Atmospheric Control Module (ACM) provides air flow to the PGC, individual PGC air flow measurement, water vapor control, heat control, CO_2 control, ethylene removal, organic control, and purgeability.

The PGC conditions are measured and controlled through a series of sensors (CO_2 , temperature, humidity), a thermoelectric cooler (TEC), and filters (ethylene, organics, CO_2 , water vapor). Temperature and humidity sensors are located within each PGC and within the ACM loop.

The temperature within the PGCs is controlled by a TEC located in the ACM loop. The average PGC temperature is compared with the programmed setpoint. If a PGC temperature change is required, the ACM loop temperature and humidity are evaluated to determine whether the TEC operation can be modified without creating condensation within the ACM loop. If required, the ACM loop can purge low-humidity Orbiter cabin air into the loop to reduce humidity, thus allowing the TEC to cool to a lower temperature.

Humidity, CO_2, ethylene, and organic contaminants are controlled through a system of filters built-into the ACM loop. The following table shows the filter bed composition for each filtration requirement.

Filter Requirement	Filtration Method
Ethylene	potassium permanganate
organics/dust	activated charcoal/mesh
CO_2	lithium hydroxide
water vapor	Nafion® tube

The ethylene, organic, and CO_2 filters are passive and are accessible during inflight operations if change out is required. The Nafion® tube is an active humidity control system and is controlled by the average PGC relative humidity.

KENNEDY SPACE CENTER FIXATION TUBE (KFT)

Dimensions: 37.5 X 3 mm
Power Requirement: None
Weight: 0.54 lbs

The Kennedy Space Center Fixation Tube (KFT) is designed to collect plant samples during flight and chemically fix the plant samples while providing three levels of containment for the chemical fixative during stowage and operations. The KFT will be used to fix two types of plants: *Brassica*

rapa for the BSTIC and BPAC experiments and soybean for the SOYPAT experiment. The KFT is comprised of six main parts: the main tube where fixative is loaded preflight; the plant tube which will be used to keep the plant in place during flight; the expansion plug; the top plug; the base plug; and the plunger. To fix a plant sample, the sample is placed into the plant tube. A plunger handle is used to push the expansion plug into the fixative, which in turn forces the fixative through an opening at the bottom of the plant tube. A total of 45 KFTs will be flown to support CUE.

For further information, please contact Guy Etheridge at the Kennedy Space Center at (407) 867-4550.

Flight Hardware: KSC Plant Growth Unit (PGU)

PLANT GROWTH UNIT (PGU)

Dimensions: 411 X 226 X 483 mm
Power Requirement: 28 VDC
Weight: 67 lbs

The Plant Growth Unit (PGU) is a self-contained unit designed to house six Plant Growth Chambers (PGCs) and occupy the same amount of space as one middeck locker. The PGU supports whole plant growth by providing acceptable environmental conditions for normal plant growth. The PGU can be configured with six PGCs or five PGCs plus the Atmospheric Exchange System (AES). The current units have flown on a total of nine space flight missions. These units have been the workhorse for Space Shuttle whole plant research.

The PGU houses the plant chambers and all experiment controls. Lamps, heaters, and fans are located within the PGU to provide temperature and lighting control. The PGU also contains displays, which are located on the PGU control panel and a Data Acquisition System (DAS). An electronic data subsystem internally controls all PGU operations such as recording data on tape, day/night cycling of the lamps, and fan speed regulation. The PGU is composed of the subsystems discussed below.

The PGU weighs approximately 67 pounds. Attachment to the Orbiter middeck is achieved by the PGU's unique adapter plate. The top-hinged aluminum front door closes off the front of the PGU with openings to permit cooling air to enter the PGU from the middeck environment.

The PGU requires 28 VDC electrical power for operation of the electronic circuits, tape recorder, lamps, fan, and heater. Power is supplied by the Orbiter through an SSP-provided cable connected to a DC utility outlet panel. The power cable is routed from the front panel of the PGU to the appropriate MUP panel location. The power usage is 81.2 W during a day cycle and 47.6 W during a night cycle. Every 15 minutes an additional 19.6 W is used for two seconds due to tape

recorder spikes. When externally provided power is interrupted, the PGU uses a non-rechargeable battery pack to operate only the data acquisition electronics and tape recorder. The lamps, fan and heater do not operate on internal battery power in order to conserve power. The PGU power switch must remain in the "ON" position. Cycling the PGU power switch resets the PGU internal clock, which complicates postflight data analysis. No damage occurs when power connections are mated or demated in this configuration.

Temperature is controlled by heat from three PGU lamps and one 20 W strip heater as well as the flow of middeck cabin air through the PGU. Temperature within each PGC is measured by a thermistor or temperature probe. The correct temperature for the PGU is maintained by comparing the control system set point temperature of 24 degrees C with the average of the two temperatures measured in PGC chambers three and six. The difference between the set point temperature and the average temperature is used by the control electronics to regulate the speed of the two cooling fans which circulate cabin air through the PGU. To maintain the desired temperature when the lamps are switched off, the strip heater is activated and the fans continue to run. The temperature settings must be above cabin air temperature to be controllable. The temperatures of the six PGCs and the ambient temperature are measured every 15 minutes and are automatically recorded on the data tape as well as monitored and recorded once a day by a crew member.

Lamps are located within the interior of the PGU to simulate a day and night cycle (16 hrs. on, 8 hrs. off). The PGU lighting system consists of a bank of three fluorescent lamps containing Duratest Vitalite phosphor lenses, a reflector, an aluminum housing, and associated circuitry. Each lamp has a very low internal pressure and is covered entirely by a Teflon sleeve to ensure that no free glass can escape if the lamps break.

The PGU Data Acquisition System (DAS) contains an analog multiplexer, a sample-and-hold circuit, and record control circuits. Data formatting circuits arrange digitized temperature and light status signals into a serial form along with a digital word for experiment time in days, hours, and minutes. The data block is assembled and processed into the recorder every 15 minutes during the mission. Analog data from the PGU are automatically recorded on a tape recorder.

The Plant Growth Chambers (PGC) are the experiment containers for the PGU. Each PGC consists of a Teflon-coated, anodized-aluminum base and Lexan cover secured to the base by four screws. A thermistor is inserted in the center of each base. Two septum ports are used, in conjunction with the AES to flow filtered cabin air through the PGC when required.

The Atmospheric Exchange System (AES) replaces one of six standard PGCs in the PGU and circulates filtered cabin air through four of the PGCs with the fifth PGC serving as a control parameter with no air flow. The AES is composed of a small instrument pump, filter, air distribution manifold, tubing and connectors, control circuitry, and display panel. The AES uses DC power from the PGU, which is powered off Orbiter DC power. A DC/DC converter steps down the input voltage from 28 V to 12 V. The AES also contains an AES alarm circuit that is triggered when there is inadequate flow through the AES or low voltage to the primary AES circuit.

The AES filter cartridge contains absorbents within a stainless steel tube. The cartridge passively regulates CO_2 by flowing the air stream over a lithium hydroxide (LiOH) bed. Some air can bypass this bed via the bypass tube, where no CO_2 is removed. The desired flow split, and therefore the desired CO_2 concentration, is obtained by installing a variable restriction orifice in the

Flight Hardware: KSC Plant Growth Unit (PGU) (continued)

bypass line. The total air stream then passes through a trace contaminant control bed consisting of Zeolite, activated carbon, and Purafil. Porous metal discs are used for bed retention and separation, with the inlet disc providing dust filtration.

The AES pump contains a small DC motor that drives a mounted piston. There are two one-way flapper valves that open and close alternately to provide airflow at a rate of 0 to 20 liters per hour. The AES manifold and distribution tubing carries the filtered air from the pump to the manifold which divides the air stream into four equal parts before it flows into the four PGCs.

PLANT GROWTH MEDIA

Nitex Sleeve/Oasis Foam Nutrient System Plantlet roots are placed in a Nitex mesh sleeve that is subsequently inserted into slots in Oasis foam. The Oasis foam is saturated with Hoagland's solution to provide water and plant nutrients. This configuration supports good plant growth and provides for easy removal of whole, intact plants with minimal damage to the roots.

Agar Tube/ Oasis Foam Nutrient System Plants or imbibed seeds are grown in agar-filled polycarbonate centrifuge tubes, which are inserted into an Oasis foam block for structural support. Water may be added to the Oasis foam to reduce agar drying.

Agar Bag Nutrient System Imbibed seeds are placed in pipette filters, which in turn are attached to the top of rectangular polypropylene bags filled with agar. The agar in the plastic bags may be stratified with different nutrients to support optimal plant feeding at different growth periods.

For further information, please contact Guy Etheridge at the Kennedy Space Center at (407) 867-4550.

Flight Hardware: Microgravity Plant Nutrient Experiment (MPNE)

MICROGRAVITY PLANT NUTRIENT EXPERIMENT (MPNE)

Dimensions: 411 X 226 X 483 mm
Power Requirement: 28 VDC
Weight: 54 lbs

Hardware developed for the Microgravity Plant Nutrient Experiment (MPNE) is configured for insertion into one standard SSP middeck locker. This hardware includes a Plant Enclosure, fluid system, light bank, Command and Data Management System (CDMS), power converter, instrumentation, fans, and Payload Container. This payload operates with 28 VDC Orbiter power.

Flight Hardware: Microgravity Plant Nutrient Experiment (MPNE) (continued)

Current planning includes flying this payload in early 1998 with wheat plants as a technology demonstration for future space flight.

The MPNE Plant Enclosure houses the plant tubes, plants, and fluid circuit. It is constructed from Lexan with a wall between the plants and the balance of the fluid circuit. Liquids and solids associated with the plants and fluid circuit are confined within one portion of the enclosure box, while the balance of the fluid circuit and a video camera are enclosed on the other side.

Active cooling is not provided for the plants in this enclosure. Plants were specifically selected to be grown in the expected environment of 80-100% relative humidity (RH) and 15-35 degree C temperatures. RH and temperature inside the enclosure is monitored by sensors and mission data is archived by the CDMS. The humidity is kept at 80% RH by circulating cabin air into the Plant Enclosure to remove excess moisture.

Fluid used in the MPNE is a plant nutrient solution made of potable water and salts. The nutrient solution is a non-hazardous fluid as evaluated by JSC Toxicology.

The fluid system includes a Water Availability Sensor (WAS) and Water Delivery System (WDS) to manipulate the plant nutrient solution. The WAS is an infrared detector and source connected to an electronics package that senses the quantity of water or plant nutrient solution on the surface of the plant tube. The WDS supplies the solution to the tube and is controlled by the CDMS from WAS input.

The fluid circuit contains and manages the plant nutrient solution for the plant tubes. The plant nutrient solution and plant solids are contained inside the circuit tubing and components. The Fluid Reservoir is enclosed in a Lexan box with a gas permeable membrane to create one level of containment. Powered components (motors, fans, Water Availability Sensor, lights) inside the payload could fail if contacted by nutrient solution. These components are powered by direct current (DC) and are inherently safe from causing damage to the payload.

The MPNE Light Bank of Light Emitting Diodes (LED) provides 100-250 μmol/m2/s of light at 660 nm and 470 nm to the Plant Enclosure. The light bank is an integral part of the Plant Enclosure.

The MPNE Command and Data Management Subsystem (CDMS) is based on the STD bus architecture. The CDMS contains seven computer board modules including a CPU board, Analog to Digital converter board, and Flash Memory board. The CDMS controls the operation of the fluid system, lighting system, and fan activation. All data from the components, lights, fans, and sensors are archived by the CPU board into non-volatile memory.

The 100 W MPNE Power Converter pair supports the payload electrical system. A triple output DC-DC converter provides +5 V, +12 V, and -12 V to the CDMS and system sensors. The single output DC-DC converter provides 12 V to the MPNE electro-mechanical devices. All connections are hermetically sealed. An electromagnetic interference filter is included to block conducted Electro-Magnetic Interference (EMI).

An alkaline battery powers a clock in the CDMS. The clock provides true event time logging throughout the mission.

The MPNE Payload Container houses all systems and components that comprise the MPNE payload. The container includes fans that provide convective cooling for the CDMS, light bank, and power converter. Filters upstream of the fans prevent debris in the cabin from entering the payload.

The ON or OFF status of the MPNE Power are constantly displayed on the front face of the container. A Liquid Crystal Display (LCD) module displays payload status and error messages. The front face of the container also includes a power circuit breaker and a power connector.

For further information, please contact Guy Etheridge at the Kennedy Space Center at (407) 867-4550.

Flight Hardware: Data Loggers

DATA LOGGERS

KSC payloads utilize small data loggers flown regularly in the Biological Research In Canisters (BRIC) payloads (which have no active environmental control) in order to have a record of the temperature, relative humidity, and ambient pressure. These data loggers are certified for flight aboard the Space Shuttle in various applications including the Extra-Vehicular Activity (EVA) suits worn by the astronauts. A detailed description of each the three varieties of data loggers follows.

HUMIDITY DATA LOGGER

Dimensions: 1.8” X 1.9” X 0.6”
Power Requirement: 3.6 V Battery
Weight: 0.9 oz

The HOBO RH is a general purpose relative humidity logger that is both durable and reusable. Its sensor resists chemical corrosion by chlorine, acetone, pentane, xylene, formaldehyde, ammonia, hospital germicides, and freon. Using BoxCar® or LogBook® software for Windows or Mac, the HOBO RH can be programmed to record for a specific duration, unplugged from the computer, and deployed. When the HOBO RH has finished recording, it is attached to the computer (via an RS-232 cable), and BoxCar or LogBook is used to read out and plot the collected information.

Features:

- Rated 5% to 95% RH non-condensing
- Accuracy ±5% tolerance at room temperature
- Two year battery life (user replaceable)
- Nonvolatile EEPROM memory retains data when the battery has been removed
- Stores up to 1800 measurements
- Safe operating temperature range of electronics is 0°C to 60°C, non-condensing
- Small size: 1.8" tall x 1.9" wide x 0.6" thick and 0.9 oz.
- Preselected intervals from 0.5 seconds to 4.8 hours, corresponding to deployment durations up to 360 days
- Blinking light confirms operation
- Data exportable to spreadsheet programs (Lotus, Excel, etc.)

PRESSURE DATA LOGGER

Dimensions: 1.8” X 1.9” X 0.6”
Power Requirement: 3.6 V Battery
Weight: 0.9 oz

The HOBO Pressure is a general purpose pressure/altitude logger that is both durable and reusable. Its pressure range runs from about 3% of atmospheric pressure to about 110% of standard sea level pressure. Using BoxCar® or LogBook® software for Windows or Mac, the HOBO Pressure is set to record for a specific duration, unplugged from the computer, and deployed. When the HOBO Pressure has finished recording, it is attached to the computer (via an RS-232 cable) and BoxCar or LogBook is used to read out and plot the collected information.

Features:

- Pressure range 0.5 to 16 psia
- Two year battery life (user replaceable)
- Nonvolatile EEPROM memory retains data when the battery has been removed
- Stores up to 1800 measurements
- Safe operating temperature range of -39°C to +75°C, non-condensing
- Small size: 1.8" wide x 1.9" tall x 0.6" thick and 0.9 oz.
- Preselected intervals from 0.5 second to 4.8 hours, corresponding to deployment durations up to 360 days
- Wide variety of pressure/altitude units
- Blinking light confirms operation
- Data exportable to spreadsheet programs (Lotus, Excel, etc.)

TEMPERATURE DATA LOGGER

Dimensions: 1.8” X 1.9” X 0.6”
Power Requirement: 3.6 V Battery
Weight: 0.9 oz

The HOBO XT temperature logger provides an external sensor for recording temperature in hard to reach areas. Using software for Windows or Mac, the HOBO XT can be programmed to record for a specific duration. When recording is finished, the unit is attached to the computer (via an RS-232 cable) and the data is read out and plotted.

Features:

Three standard ranges: -5°C to +37°C; -37°C to +46°C; and -39°C to +123°C
Two year battery life (user replaceable)
Precision external thermistor probe on a flexible cable (ordered separately)
Standard cable lengths are 1, 2 and 6 feet
Operating temperature of logger is -39°C to +75°C
Optional submersible case rated to 400' depth
Small size: 1.8" tall x 1.9" wide x 0.6" thick and 0.9 oz.
Nonvolatile EEPROM memory retains data even when the battery has been removed
Stores up to 1800 measurements
Preselected intervals from 0.5 second to 4.8 hours,
corresponding to deployment durations up to 360 days
Blinking light confirms operation
Data readout in less than 30 seconds
Data exportable to spreadsheet programs (Lotus, Excel, etc.)

For further information, please contact Guy Etheridge at the Kennedy Space Center at (407) 867-4550.

Flight Hardware: ASTROCULTURE™ Plant Growth Unit

Description:

The ASTROCULTURE™ flight unit (ASC) was developed by the Wisconsin Center for Space Automation and Robotics, University of Wisconsin-Madison. The flight unit includes a controlled environment chamber for supporting plant growth in a microgravity environment for up to three months. The single middeck locker unit is energy efficient (less than 150 W) and lightweight (less than 32 kg including the locker). On-board sensors for monitoring and controlling the environmental parameters, video recording capability, and virtually autonomous operation make this a unit that can accommodate a variety of plant experiments. Data are available for assessment of performance capabilities.

Functional Capabilities:

- Totally enclosed plant chamber, 14 x 14 cm growing area, 25 cm growing height not including the root zone
- Temperature control in plant chamber over range of 18° C to 40° C, ± 1° C
- Humidity control in plant chamber over the range of 50% to 95% RH, ± 2% RH
- LED lighting unit with total intensity of 600 µmol m^{-2} s^{-1},(including 50 µmol m^{-2} s^{-1} blue photons) and ratio of blue to red photons adjustable from 0 to full output
- Carbon dioxide concentration control in plant chamber over range of 300-2000 ppm
- Ethylene removal unit
- Porous tube water and nutrient delivery system
- Environmental parameter monitoring and recording data acquisition system
- On-orbit video and digital data download and subsequent downlink capability

Flight History:

STS-50, USML-1, Columbia, 6/25/92 - 7/9/92
STS-57, SPACEHAB-1, Endeavour, 6/21/93 - 7/1/03
STS-60, SPACEHAB-2, Discovery, 2/3/94 - 2/11/94
STS-63, SPACEHAB-3, Discovery, 2/3/95 - 2/11/95
STS-73, USML-2, Columbia, 10/20/95 - 11/5/95
STS-89, MIR, Endeavour, 1/20/98 - 5/15/98
STS-95, SPACEHAB-SM, 10/29/98-11/7/98

For further information, please contact:

Weijia Zhou, Ph.D.
Wisconsin Center for Space Automation and Robotics
College of Engineering
University of Wisconsin-Madison
Room 2348 Engineering Hall
1415 Engineering Drive
Madison, Wisconsin 53706-1691
Phone: (608) 262-5528
Fax: (608) 262-9458
e-mail: wzhou@facstaff.wisc.edu

Flight Hardware: Plant Generic Bioprocessing Apparatus (PGBA)

Description

The Plant Generic Bioprocessing Apparatus, designed by BioServe with support from WCSAR (Wisconsin), NASA/Ames, and NASA/Code UX, has successfully supported plant biotechnology experiments in space that examine changes in plant growth and related downstream biochemical consequences, especially production of secondary metabolites. PGBA has also demonstrated the successful development of several challenging systems for autonomous support of plants in the spaceflight environment. PGBA consists of several modular subsystems such as the outer enclosure module (the structural interface to the orbiter), the sealed internal plant growth chamber, the atmosphere isolation and control system, the heat removal (temperature control) and humidity control system, as well as the nutrient delivery and rooting matrix system. Data acquisition for PGBA includes plant growth data through video and plant performance data. All sensor data are recorded by the PGBA Data Acquisition and Control Computer, while an internal video camera provides video images that can be recorded or down-linked to Earth in near real-time. PGBA first flew in Spacehab on shuttle mission STS-77 in May of 1996 (10 day duration), and again on the Spacelab MSL-1 flight (STS-83) in April of 1997 (4 day actual) and STS-94 in July of 1997 (16 day duration). Ground experiments have been conducted in excess of 45 days duration.

Functional Capabilities

Power Supply	22-36 VDC (230 W peak at 28 VDC) orbiter power
Payload Mass	53.5 kg / 120 lbm, max, allowable for double locker payload
Payload Volume	H 56 cm x W 46 cm x D 51 cm (double middeck locker)
Plant Growth Volume	25 cm x 30 cm base x 30 cm high (6.6 cm root depth)
Rooting and Nutrient Matrix	- 30 individual 'bags' (5x5x6.6cm) that hold up to four plants each - Solidified nutrient agar or soil in gas exchange bag with and without regenerative water resupply capabilities, other optional modular rooting and nutrient delivery systems
Light	Compact fluorescent lamps, up to 550 μmol m^{-2} s^{-1} at top (100% power regulation), with a minimum of 220 μmol m^{-2} s^{-1} at root/shoot level (60% power regulation)
Environmental Control	20-32 ± 0.2ºC air temperature, 75 – 100 ± 3 % RH, 300 - 3000 ± 30 ppm CO_2, ≈ 21% O_2 (≈ 30% O_2 if EVA), catalytic ethylene removal, humidity condensate recycling
Data	On board recording of 32 channels (environmental data: temperature, pressure, humidity, carbon dioxide, oxygen); data downlink and payload commanding through orbiter data system, video downlink or on-board storage (digital)

Contacts BioServe Space Technologies, Campus Box 429, Boulder, CO 80309
http://www.colorado.edu/engineering/BioServe/PGBA.htm
Dr. Alex Hoehn ph: (303) 492-5875 fax: (303) 492-8883
hoehn@spot.colorado.edu
Dr. Louis Stodieck ph: (303) 492-4010 fax: (303) 492-8883
stodieck@stripe.colorado.edu

Flight Hardware: Biomass Production System (BPS) Plant Growth Unit

Equipment Provider: Orbital Technologies Corporation (ORBITEC)
Available Date: December 1999

Description

The Biomass Production System (BPS) provides precise environmental control for plant science and biotechnology experimentation. The BPS replaces two middeck lockers (vertically) and operates using 28 VDC orbiter power. The BPS provides its own double adapter and shell and can be accommodated in the Shuttle Middeck, the SpaceHab Module, and the EXPRESS Rack. The baseline BPS unit contains four chambers that are removable to provide access to specimens through all phases of operation. Each chamber is 6.5"(L) x 5.8"(W) x 7.4"(H) and provides independent control of temperature, humidity, lighting, and CO_2 levels. The chambers are sealed to allow for *in situ* gas exchange measurements (e.g., photosynthesis, transpiration). The current BPS design can be adapted to accommodate different chamber configurations including two tall chambers 6.5"(L) x 5.8"(W) x 15.9"(H), 2 long chambers 6.5"(L) x 14.8"(W) x 7.4"(H), or a single large chamber 6.5"(L) x 14.8"(W) x 15.9"(H).

Functional Capabilities

System performance specifications for BPS include:

- Temperature: 20-35 degrees C
- Relative Humidity: 60-90%
- Light Level: 50-400 µmol m^{-2} s^{-1}: baseline cool white fluorescent lamps
- CO_2 Enrichment: to 3000 ppm
- Water Supply/Collection: Two 500 ml reservoirs
- Ethylene Scrubbing: <50 ppb

Major functional features of the BPS include:

- Advanced control system
- Flexible data handling programmability
- Menu driven interface with optional user defined displays
- Enhanced data and image acquisition/storage,
- Color video standard, IR available
- Ethernet and 3.5" disk drive for direct data interface
- Multiple gas/liquid sampling ports
- Active nutrient delivery system, scarred for other nutrient delivery systems
- Metering of nutrient supply & condensate recovery systems in 0.03 ml increments
- Real time video output
- High resolution color front panel display
- Interface keypad
- Operational status indicators
- Interfaces for standard keyboard and monitor for ground operations
- Fully equipped 586DX4 133MHz single board computer
- Internal 2.1 GB harddrive
- Replenishable CO_2 supply, H_2O supply, Regenerative H_2O recovery loop

- Subsystems modular design for servicing/replacement w/alternative configurations

Contacts Mr. Thomas Crabb or Dr. Robert Morrow
Ph: (608) 827-5000 Fax: (608) 827-5050 Email: crabbt@orbitec.com

APPENDIX C
NRA 99-HEDS-01

Instructions for Proposal Preparation and Required Application Forms

This section contains the general instructions for proposal preparation and the specific forms required by proposers responding to this Announcement. This section is specific to this NRA and supercedes the information contained in Appendix D. The forms at the end of this section include the following:

Form A	Solicited Proposal Application
Form B	Proposal Abstract
Form C	Space Flight Experiment Preliminary Description Form (required for Flight Experiments only)
Form D	Biographical Sketch
Form E	Other Support
Form F	Detailed Budget, First Year
Form G	Detailed Budget, Entire Project Period
Form H	Checklist for Proposers

Instructions for Proposal Preparation

All proposals must include each of the forms provided in this Appendix as part of the complete submission, with the exception of Form C, which is submitted only with flight experiments, and Forms F and G, which are not required for some non-U.S. proposals (see the form-specific instructions included in this Appendix).

The proposal must include the following material, in this order:

1. Cover Page: Solicited Proposal Application (Form A), including certification of compliance with U.S. code (if applicable)*
2. Proposal Abstract (Form B)

3. Proposal Title Page, with Notice on Restriction on Use and Disclosure of Proposal Information, if any
4. Project Description Preface (Revised Proposals only)
5. Project Description
6. Space Flight Experiment Preliminary Description Form (required for Flight Experiments only) (Form C)
7. Management Approach
8. Letter of Assurance of Foreign Support (if applicable)
9. Biographical Sketch (Form D)
10. Other Support (Form E)
11. Facilities and Equipment
12. Special Matters (specific information on animal or human subjects protocol approval required, if applicable)*
13. Detailed Budget, 12 Month (Form F)
14. Detailed Budget, Entire Project Period (Form G)
15. Supporting Budgetary Information
16. Checklist for Proposers (Form H)
17. Appendices, if any
18. Computer diskette (3.5 inch, Macintosh or PC format) containing an electronic copy of the principal investigator's name, address, telephone and fax numbers, e-mail address, and the complete project title and abstract as provided on Form B

* One signed original required

The Project Description Section is limited to 20 pages. Any pages in this section beyond 20 will not be reviewed. There is no specific page limitation on other sections of submitted proposals. However, every effort should be made to keep proposals as brief as possible. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the forms in this Appendix where special places are provided for this information. Note that the proposal must specify the period of performance for the work described. Periods of performance may be for any duration up to three (3) years but should be suitable for the project proposed.

(1) Cover Page: Solicited Proposal Application (Form A)

All of the information requested on Form A must be provided, and one original signature version of this form should be submitted. This form meets the requirements of the transmittal memo described in Appendix D, Section C (1).

For Item (7) on this form, new means that a proposal for this project has not been submitted to NASA in 1996, 1997,or 1998, renewal means that this proposal is for the continuation of a currently funded task beyond the term of the funded proposal, and revised means that this proposal represents a revision of a proposal submitted to NASA and reviewed in 1996, 1997, or 1998, but not funded. A proposal previously submitted but not funded should be termed revised even if the original Principal Investigator has changed. Renewal and revised applications should contain special material described in the Project Description section below.

Note: Items (9) and (10) on Form A require assurance of compliance with human subject or animal care provisions of NASA regulations (see "Special Matters" section below). If IRB or ACUC review is unavoidably delayed beyond the submission of the application, enter "Pending" on line 9b or 10b in Form A. Applicants should be aware that proposal review will not be undertaken without prior assurance of compliance.

(2) Proposal Abstract (Form B)

The information requested on this form is essential to the review of the proposal. It determines how the application will be evaluated and which program manager(s) will receive the final review materials for possible inclusion in one of the research programs of the Office of Life and Microgravity Sciences and Applications.

(3) Proposal Title Page

The Title Page should contain the project title, name and address of the submitting institution, the name, address, and telephone number of the Principal Investigator, and the names and institutions of any co-investigators. It is NASA policy to use information contained in proposals for evaluation purposes only. While this policy does not require that the proposal bear a restrictive notice, offerors or quoters should, in order to maximize protection of trade secrets or other information that is commercial or financial and confidential or privileged, place the following notice on the Title Page of the proposal and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals will be protected to the extent permitted by law, however, NASA assumes no liability for use and disclosure of information not made subject to the notice.

NOTICE

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(4) Project Description Preface (Revised Proposals only)

Revisions of 1996, 1997, or previous 1998 submissions to the NASA Office of Life and Microgravity Sciences and Applications must include a preface to the project description. This preface should be two to three pages in length and must contain clearly notated responses to the criticisms of the previous review. The pages in the preface will not count toward the 20 page limit of the project description. Revised proposals require further notation as described in the next section of this Appendix. Note that revised applications that do not address the criticisms in the previous critique or do not include substantial revisions will be considered unresponsive and will be returned without review.

(5) Project Description

The length of the Project Description section of the proposal should not exceed 20 pages using regular (12 point) type. **Pages beyond 20 will not be reviewed**. The proposal should contain sufficient detail to enable reviewers to make informed judgments about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with the resources requested and with their own resources. In addition, the

proposal should clearly indicate the relationship between the proposed work and the research emphases defined in this Announcement.

Renewal applications (for competing renewal of currently funded activity) must include a progress report as an Appendix to the proposal, and should refer to this Appendix appropriately throughout the Project Description section.

Revised applications (revisions of 1996, 1997, or 1998 submissions) must include appropriate notation in the project description. Applicants must highlight the changes they have made in their research plan by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was submitted. Note that revised applications that do not address the criticisms in the previous critique (in a Preface as described above) or do not include substantial revisions will be considered non-responsive and will be returned without review.

(6) Space-Flight Experiment Preliminary Description Form (if applicable, Form C)

All applicants proposing space flight research must provide the information requested on Form C. The information on this form is essential for the evaluation of the feasibility of performing the proposed study.

(7) Management Approach

Each proposal must specify a single Principal Investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the Management Approach section should define the roles and responsibilities of each participant, and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

(8) Letter of Assurance of Foreign Support

Applications submitted by non-U.S. entities as well as applications with non-U.S. participation submitted by U.S. entities must include a written endorsement from the respective agency or funding/sponsoring institution (see Appendix A, Section VI, Part C of this Announcement for details).

(9) Biographical Sketch (Form D)

The Principal Investigator is responsible for direct supervision of the work and must participate in the conduct of the research regardless of whether or not compensation is received under the award. A short biographical sketch of the Principal Investigator that includes his or her current position title and educational background, a list of principal publications, and a description of any exceptional qualifications must be included. Use Form D to describe the research and professional experience of each professional staff member. Concluding with present position, chronologically list previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. Do not exceed two pages. Omit social security numbers and other personal items which do not merit consideration in evaluation of the proposal. Provide similar biographical information on other senior professional personnel who will be directly associated with the project. Provide the names and titles of any other scientists and

technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(10) Other Support (Form E)

Use the format described in Form E to list other sources of research support (including active NASA support) for the proposed Principal Investigator and each of the proposed Co-Investigators. Please list all active support, as well as any pending support.

(11) Facilities and Equipment

Describe the available facilities and major items of equipment specially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. Provide evidence that such facilities or equipment will be made available if the applicant is successful in obtaining funding. Before requesting a major item of capital equipment, the proposer should determine if the sharing or loan of equipment already within the organization is a feasible alternative to purchase. Where such arrangements cannot be made, the proposal should so state. The need for items that can be typically used for research and non-research purposes should be explained.

(12) Special Matters

The Special Matters section must contain a statement from the proposer's institution which states that the proposed work will meet all Federal and local human subject requirements and animal care and use requirements, if applicable. Note that no animal subjects may be utilized unless specific information justifying and describing their use is included in the proposal. Policies regarding the protection of human research subjects in NASA-sponsored research are detailed in NASA Management Instruction (NMI) 7100.8B (Protection of Human Research Subjects), and animal care and use requirements are detailed in the NASA Code of Federal Regulations (CFR) 1232 (Care and Use of Animals in the Conduct of NASA Activities), both of which are available from the Office of Life and Microgravity Sciences and Applications, NASA Headquarters, Washington, DC 20546. Assurance of compliance with human subject or animal care provisions is required on Form A, to be submitted with each proposal. In addition, a letter signed by the chairperson of the Institutional Review Board (IRB), institutional Animal Care and Use Committee (ACUC), or both, as appropriate, regarding approval of the experimental protocol, should be included with each copy of the proposal. If IRB or ACUC review is unavoidably delayed beyond the submission of the application, the certification must be received within 60 days after the due date for which the application is submitted. If certification is not received within 60 days after the application due date, the application will be considered incomplete. NASA shall require current IRB or ACUC certification prior to award. All U.S., non-NASA proposals providing ACUC approval must also contain the institution's Public Health Assurance number.

(13) Detailed Budget, 12 Month (Form F) and (14) Detailed Budget, Entire Project Period (Form G)

These forms must be submitted with each U.S. proposal, or with non-U.S. proposals that have a U.S. component for which NASA funding is sought. NASA intramural Principal Investigator’s research budgets for all years are to be submitted in a full-cost mode in accordance with the NASA CFO, Enterprise Office, and Center full-cost budget policy. Funds to support the Resident Research Assistant (RRA) Postdoctoral Program costs (e.g., stipend, travel, computer time, supplies, etc.) are to be budgeted within the NASA intramural Principle Investigator budget.

Foreign proposals with no U.S. component should not submit these forms.

(15) Supporting Budgetary Information

This section must include information that supports the costs submitted in Forms F and G. In this solicitation, the terms "cost" and "budget" are used synonymously. Sufficient proposal cost detail and supporting information are required; funding amounts proposed with no explanation (e.g., Equipment: $1,000, or Labor: $6,000) may cause delays in evaluation and award. Generally, costs will be evaluated as to realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained in this section. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following indicate the suggested method of preparing a cost breakdown:

Direct Labor

Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means including comparison to similar skills at other organizations.

Other Direct Costs

Please detail, explain, and substantiate other significant cost categories as described below:

- Subcontracts: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
- Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and the rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).
- Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested as a direct charge must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
- Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.
- Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
- Other: Enter the total of direct costs not covered by a) through e). Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on

allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as: application base equals total costs before G&A less subcontracts.

All awards made as a result of this NRA are to be funded as grants and will not be negotiated as contracts. Therefore, while proposals submitted by "for-profit" organizations are allowed, they cannot include a "fee."

(16) Checklist for Proposers (Form H)

One copy of a completed version of this checklist should be attached to Form A of the original proposal.

(17) Appendices, if Any

Renewal applications (for competing renewal of currently funded activity) must include an appendix providing a Progress Report of the previously funded activity. This report should provide the beginning and ending dates for the period covered since the project was last reviewed competitively, and provide a list of all personnel who have worked on the project during this period (including dates of service and percentages of their appointments devoted to the project). The report should also summarize the previous project's original goals and specific objectives, and provide a succinct account of published and unpublished results indicating progress toward their achievement. Changes in these objectives during the course of the project and a rationale for these changes should be presented. The importance of the findings should be summarized and discussed. Finally, a list should be provided of the titles and complete references to all publications, manuscripts submitted or accepted for publication, patents, invention reports, and other printed materials that have resulted from the project since it was last competitively reviewed.

Other appendices may be appropriate for particular proposals.

(18) Computer Diskette

A diskette (3.5 inch, Macintosh or PC format) should contain an electronic copy of the Principal Investigator's name, address, telephone and fax numbers, e-mail address, and the complete project title and abstract as provided on Form B.

The Required Application Forms

must be downloaded separately from

http://peer1.idi.usra.edu/peer_review/nra/99_HEDS_01.html

APPENDIX D
NRA 99-HEDS-01

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

(JANUARY 1997)

A. General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRA's contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRA's are subject to the Federal Acquisition Regulation and the NASA FAR Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRA's; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

B. NRA-Specific Items. Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

C. Proposal Content. The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) *Transmittal Letter or Prefatory Material.*

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) *Restriction on Use and Disclosure of Proposal Information.* Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

Notice

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) *Abstract*. Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) *Project Description.*

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) *Management Approach*. For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) *Personnel*. The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) *Facilities and Equipment.*

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) *Proposed Costs.*

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major
work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(9) *Security*. Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) *Current Support*. For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) *Special Matters.*

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

D. Renewal Proposals.

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

E. Length. Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

F. Joint Proposals.

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

G. Late Proposals. A proposal or modification received after the date or dates specified in an NRA may be considered if doing so is in the best interests of the Government.

H. Withdrawal. Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

I. Evaluation Factors.

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

J. Evaluation Techniques. Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

K. Selection for Award.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

L. Cancellation of NRA. NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.